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Evaluating the effectiveness of the new biology curriculum for fourth grade students in Iran.

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EVALUATING THE EFFECTIVENESS OF THE NEW BIOLOGY CURRICULUM FOR FOURTH GRADE STUDENTS IN IRAN

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ABSTRACT

Educational systems in developing countries are under the influence of factors which have critical effects on curriculum evaluation and interpretation of its effects.

A model for curriculum evaluation was developed, in the present study, to evaluate the effectiveness of a new biology curriculum implemented in 1974 in the Iranian system of education. The target population were 14-15 year-old students and their teachers at the first year of the secondary education in four state capital cities and 43 schools. The teachers had previously been to an in-service course. The curriculum material consisted only of a single textbook for students.

The model for curriculum evaluation was a summative model. It was developed in two stages: (1) pilot study stage, to investigate problem areas and develop the instruments; and (2) fieldwork or experimental stage to evaluate the innovation. The model emphasised the use of both experimental and illuminative evaluation strategies to evaluate the intrinsic and extrinsic criteria.

The results obtained from the application of the above model suggested that most of the curriculum objectives were attainable if the textbook could be taught completely.

In reality students and their teachers had reached a compromise about what should be taught and what should be learnt. The results from 45 criterion-referenced ecology test items showed that a selective number of concepts and principles were taught in each individual school. However, the high marks obtained by students in the teachers' examination proved that they were fulfilling the official cut-off

score (12 out of 20).

The above model, although used to evaluate the biology curriculum, seems to have a universal application for evaluating other subjects. It can be used for curriculum evaluation in any developing country that has similar characteristics to those in Iran.

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In the present thesis references for each chapter or appendix have been quoted at the end of that chapter or appendix to facilitate the tracing of these references. Therefore, no additional bibliography was prepared.

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CHAPTER ONE

THE IRANIAN SYSTEM OF EDUCATION

There are four distinct periods in the long Iranian history of education that continuously affect the present system of education:

1. The pre-Islamic period, represented by a rigid class structure and two systems of education, one for the mass, and the other one for the nobles.
2. The Islamic period, distinguished by Islamic culture and its adoptive, feudal policy.
3. The Westernization period, characterized by the introduction of an additional and separate system of education for training bureaucratic manpower for reformist, feudal policy.
4. The Modernization period, represented by the vast expansion of all levels of the new system of education, especially the secondary and higher education; and a reformist monarchy.

The present system of education is the result of contradiction, acceptance, revival and rejection of the above cultural and educational values. In the present chapter the first two periods are discussed. The Westernization and Modernization periods are elaborated in the next chapter.

1.1 Education in Pre-Islamic Period

There were two systems of education in ancient Iran; one for the masses, and one for the nobles.

The nobles' children from the age 5-15 studied the three R's, moral and religious education and physical education at the Court schools. From the age of fifteen onwards, the education of youth was either carried out at the fire-temple (for religious education) or at the assembly placed called *Agora* (for physical education) (1).

The method of teaching was based on rote memorization of facts. The teacher was either a member of the priesthood or royal family and the body of state governors. Being a member of a high class, the teacher enjoyed a high status and respect.

The aim of education was to educate the nobles' children as useful members of the society:

> "A child who will fulfil his duty in society; a child who will strive for the happiness of his family, his city, and his country; an honourable child who may contribute to others' needs." (2).

Physical education was very important: "a good mind should have a healthy body to live in". Every effort was made to mould every child's mentality in the same way. This ideology, preventing any manifestation of individualism, maintained the Emperor's absolute authority, and was one of the main reasons that led to the decline of the Iranian old empire, which was eventually terminated by Arabs' invasion. (3).

The mass education was carried out at home and in society. Children of the age 5-15 had to learn their father's profession by apprenticeship. From the age of 15, participation in religious ceremonies was part of their social education.

In pre-Islamic period, four social classes, priests, warriers, artisans and peasants were easily identified. The bureaucrats and priests had access to formal education, through which they were educating their children for bureaucratic jobs and professions. The mass were illiterate and could either learn a vocational job or become a warrior. This rigidity of social class was such that a child was not only born in a social class but also into the same rank within that class order as his father. This pattern of social class was supported by Zoroastrian instructions to support the state. (4).

In this period of time, art and elaborate handicrafts developed extensively and a University of Ghondishahpour was established for higher education.

1.2 Islamic Period

The Arab invasion in 642 A.D. disrupted Iranian social and educational life.

There are several reasons responsible for the puzzling defeat of the massive Iranian army by a small group of Arabs. Some of them could be:

(a) The rigidity of the social class structure and one-way flow of power that kept the lower classes in a position of subjection contradicting with the equality Islam was advocating.

(b) The education of nobles, which was based on rote memorization and negation of any individual initiative and decision-making in running the state affairs. These handicapped nobles could not lead the country when at the end of the Sassanid reign some had a chance to become an emperor for a short while.

(c) The simplicity of Islam, and similarities between its principles, and Zoroastrian religion. The increasing interference of the Zoroastrian priests in state affairs and their emphasis on the details of the religious ceremonies and formalities rather than the real teaching of Zoroaster, had distracted people from this religion.

However, it took 400 years, by the Arab invaders, for complete capture of Iran.

1.2.1 Islamic Educational Institutions

The Arab invaders were mostly a group of nomadic and illiterate people who were so proud of their language, in which God had his message to mankind - the Holy Koran. They believed that all a muslim needs to know about life is covered in the Koran. The expansion of the Islamic empire and the need of the people to learn the Koran introduced the written language and facilitated religious teaching and instruction.

The early Koranic schools were naturally at Mosques where every muslim had to give a daily visit to pray or discuss his religious problems with the *Ulema* (knowledgeable priest). Increasing demand for literacy created private schools where literate people could teach children, for a small fee. The Koranic school or *Maktab* (primary school) was the urban elementary institution to give the basic knowledge a muslim needed to know in an Islamic society. For most of the people, this education was the end of their formal education.

The curriculum of a *Maktab* in Iran hardly changed in the first 12 centuries after Arab invasion. The first 3-4 years of schooling were spent in reading and memorizing some passages from the Holy Koran as accurately as possible. Later, they would learn some mathematics, and writing some paragraphs from the Koran. "To safeguard the holy writ from being defiled" (5) an elaborate hand-writing was used.

In the later times, some classical Iranian literature - poets and other masterpieces - was also added to the *Maktab* curriculum. However, religious instruction was indispensible from all the above curricula and was carried out by home, society and school.

For a girl, the ability to read the Koran and some Persian literature was all she was entitled to learn. Her later education was carried out by her mother, and after marriage by her mother-in-law, to practise cooking, washing and looking after the family.

The method of teaching was rote recitation and memorization; corporal punishment was common (6) (7) if children were to develop suitable manners. (8).

For those interested muslims who wished to study beyond the *Maktab* curriculum, there were at least three kinds of opportunities provided:

1. They could attend a lecture delivered by a scholar in a mosque.

2. They could attend a famous circle *(Halka)*, whereby a group of persons would meet with a scholar in a mosque to discuss some aspect of the Koran. Or,

3. They could apprentice themselves to a learned man and spend varying amounts of time with him until they had learned as much as they desired.

The last category was a common practice for poor students who could benefit from the scholar's knowledge free of charge.

However, for those who could afford a further education, the *Madrasa* (college) was the place to register after the age of 15. In the *Madrasa*, according to the numbers of the students and availability of the teachers, every subject was taught and upon the completion of a course a written certificate *(permission)* was given by the teacher to certify the student's achievement under his supervision. (9).

Teachers of the *Madrasa* were either graduates of the same or another *Madrasa* or a university, or they had worked with an eminent member of the *Ulema*.

Some madrasa were acting as research centres, e.g. *Nezamiyeh*, founded in 1057 A.D. by Nizam-al-Mulk in Baghdad, was to fulfil the bureaucratic need of the political elite and to control the influence of religious leaders on public opinion and finally to train qualified persons to disseminate government ideology in other teaching and learning centres. (10).

In the *Sufi' Khaneghahs* also many eminent scholars such as Al-Farabi and Aricenna, who played an important role in Islamic education (11), were trained.

The first five centuries after Arab invasion are called the Golden Age of Islamic Culture. At this period of time, many books from different languages were translated into Arabic; Iranian and Arab scientists produced many scientific masterpieces and inventions. (12).

In the later centuries, due to the reasons discussed in the following pages, the curriculum of *Maktab* and *Madrasa* ossified and, in the fifteenth century, the study of science and mathematics was eliminated from the curriculum. Figure2.1. shows the general pattern of the Islamic system of education.

1.2.2 Islamic Culture and Education

Islamic culture cannot be studied apart from Islamic education, social or political content. Szyliowicz (13) describes this point as follows:

"The word 'Islam' literally means 'submission' and a muslim is the one who has submitted to the will of God, Allah, and who acknowledges Mohammed as his messenger. Submission is not limited either temporally or functionally; all is sacred, so that Islam determines and sanctions all aspects of life - private and public, political, social, economic and educational, as well as religious beliefs and activities. Accordingly, any change or innovation tends to be restricted as being against sanctified tradition, and adapting Islam to the requirements of the modern world is one of the basic problems confronting all muslims." (14).

Therefore, this view of Islam and its view of knowledge, to acquire as much of the accepted wisdom as possible, was one of the reasons that ossified the Islamic system of education in the later centuries.

On the other hand, the language of the Koran was not understandable for children who had different local language and culture. The most effective method was rote memorization under the threat of corporal punishment. Therefore in the *Maktab* a child memorized the Koran and in the mosque the student memorized the teachers' notes. The discussion about a lesson that was commonly used in *Madrasa*, amongst peer groups, was to convince the enquirer by verbatim and logical argument of the validity of the teachers' notes. (15).

In spite of the high value of education in Islam, the primary teachers never enjoyed a respectable and high status. The reason for this situation could be traced in the following aspects of the Islamic culture:

1. The *Maktab-dar* or the primary school teacher, dealt with literacy and did not need any professional qualification, which contrasts with the education required of an *Ulema*. Anybody with minimum knowledge about religion and ability to read and write the Koran could establish a Koranic school.
2. The objective of the Arab invader was primarily to teach Islam, the Holy Koran, to other people. The question of paying a teacher to instruct the holy writ to children deeply agitated many Islamic theologians. (16).

It was not unusual to find mocking comments about the stupidity of the primary school teachers in Islamic writings.

Ulema, *Madrasa* and college teachers gained a very high status in society.

The *Ulema* were a group of knowledgeable priests who emerged from the early Islamic period and established themselves as the teachers, the judges and the source of any knowledge related to interpretation of new problems in terms of Islamic laws. In time, their Control of Wagfs (religious tithe), educational system and their influence on people's opinion created a close tie amongst *Ulema* and the ruling elite, merchants, and the craftsmen, as well as with the common people. "Since it was possible for *Ulema* to make careers for themselves as merchants or bureaucrats and for the craftsmen and merchants to become members of the intellectual and religious elite." (17).

The role of the *Ulema* as the source of disseminating Islamic laws and knowledge and their autonomy of power created many changes in the Islamic religion and culture:

(a) Their support of the state and exclusion of the rural population from literacy, maintained their power over the mass. This control was enforced by creating oral religious instructions and special detailed instructions for every aspect of life to prevent the development of independent opinion and interpretation.

(b) The education of women was totally neglected and their participation in social activities was carefully defined and restricted.

(c) The study of science and mathematics, which could lead to the questioning of their authorities and

Islamic culture and traditions, was abandoned from the school curriculum at the height of the *Ulema's* power. (18).

(d) Religious superstitions and prejudices were encouraged. This was coupled by elimination of the teaching of other sects of Islam, than shi'i, in the *Madrasa*.

(e) The involvement of *Ulema* in political activities led to the corruption and deterioration of the *Madrasa* system since they were used as a means for state employment. (19).

At the end of the seventeenth century the shi'i became the official religion of Iran and there were seven classes in the feudal country: the ruling class, the bureaucratic middle class, the bourgeois middle class, the priestly middle class, the traditional working class, the peasant, and the nomadic class. (20). The relationship between these classes and the Shah could be represented as the Figure 1.1. This Figure shows the pattern of social structure that persisted from the seventeenth century until recent time. (21).

Since any innovation introduced into this system was secured to maintain the traditional structure, values, beliefs and pattern of interaction, the policy of the Islamic feudal system was called adaptive.

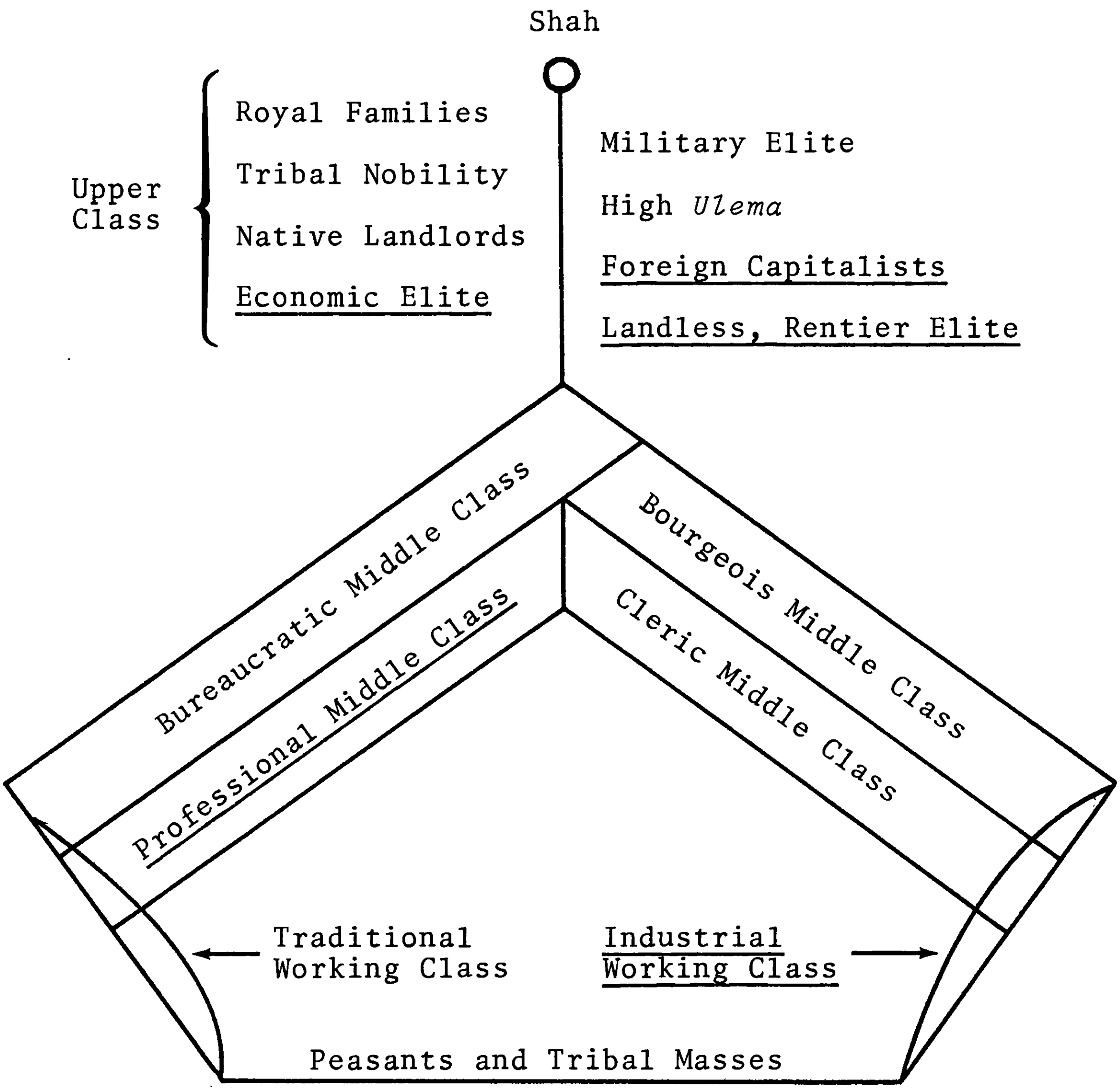
1.3 Summary

The rigidity of the pre-Islamic class structure was relaxed by Aran invasion in 642 A.D. In the early Islamic period, due to the disruption of the old system of education and the efforts of the invaders to literate the mass, a massive progress in all branches of science developed.

In time some intrinsic characteristics of Islam led to the stagnation of the system of education, particularly the school curriculum. The following are some of the main reasons for this development:

1. The development of Koranic schools, *Madrasa* and the emphasis on rote memorization as the only method of teaching and learning influence the whole educational system.
2. The omission of science and mathematics from school curricula prevented further progress of these sciences.
3. The adoption of the shi'i sect of Islam as the official religion, and the omission of teaching of other branches of Islam in *Madrasa*, prevented the flow of thoughts and healthy communication between various theologians. It led to a static religious knowledge and curriculum.
4. The involvement of *Ulema* in politics and government and their role as spiritual, religious and secular guide initiated the allocation of the same status for the government. It followed that any opposition to the government was considered to be against the religion. Also, any innovation which could endanger the political status quo would be rejected. This led to an adoptive, feudal policy.

Figure 1.1: A descriptive view of Iranian class structure at the beginning of Pahlavi dynasty. (1).



(1) Adopted with modification from:
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CHAPTER TWO

THE IRANIAN SYSTEM OF EDUCATION - WESTERNIZATION AND MODERNIZATION PERIODS

In 1851, Amir Kabir, the grand wazir of Shah Wasir-al-Din, founded a polytechnic school, Darolfunun, to train new officers for the newly established army.

Darolfunun was an elitist school, tuition was free and pupils were subsidized with two uniforms annually. (1). Children who had finished *Madrasa* could enter Darolfunun at the age 14-16. (2). The teachers were French and Austrian and the curriculum was a mixture of secondary and higher education curricula.

The establishment of Darolfunun and the emphasis on Science and Mathematics teaching revealed the deficiency of the *Madrasas'* curricula in preparation of students for this institute. Therefore a limited number of modern schools were established in large cities.

2.1 Westernization Period

The effect of Darolfunun on the introduction of western values and institutions could be summarized as follows:

(a) The revival of teaching Science and Mathematics after 200 years, and the translation of French textbooks, introduced these subjects into the traditional system of education.

(b) The employment of *Madrasa* teachers for teaching Science in modern schools penetrated the traditional teaching method in these schools and in later years in the Darolfunun.

(c) The 1100 graduates of Darolfunun and those who returned from foreign countries created a social revolution which eventually lead to the establishment of the constitution in 1906. (3). Following this event, a Ministry of Education was established and the government became responsible for elementary compulsory education. (4). But due to the power of the *Ulema* an article was included, in the educational law, to exclude any textbooks that might anger students' religious beliefs and instruction of Shiite catechism was made a compulsory part of elementary and secondary curricula. (5).

(d) The expansion of western bureaucratic departments created an urgent need for in-service training. Therefore each Ministry established a college which in later years founded various faculties of Tehran University. The Ministry of Education was the last Ministry to realize the need for training for teachers. However, in 1928 a normal school was upgraded as a Teachers' Training College. In 1934, when Tehran University was established, this college became part of the university. (6).

In 1925 Colonel Reza Khan, an army officer, became the most powerful man in Iran and founded the Pahlavi dynasty. He was crowned as Reza Shah.

Reza Shas's main objective, to westernize the country, was to create a unified Iran and revive the glory of the past. To achieve this objective he realized the need for a strong army to eliminate the autonomy of the local governments and the power of rebellious nomads and tribes.

Since the army required manpower educated by a new system of education, he established and imposed the following changes in the whole system of education. (7)(8).

1. He gave an absolute power to the Ministry of Education over every phase of educational process ranging from examinations to literacy exerci ses.
2. He established a highly centralized government.
3. He ordered that Farsi become the only language for teaching and learning.
4. He gradually abolished all the foreign-sponsored schools.
5. He imposed a modern curriculum in the *Maktab* and *Madrasa*.
6. He eliminated the influence and power of the *Ulema* by adopting anti-Islamic attitudes:
   (a) In 1941, he abolished religious instruction for all students.
   (b) In 1933, he opened co-educational primary schools.
   (c) In 1935, women were admitted to higher education institutes.
   (d) He ordered government employees to abandon the *Ulema* clothes and wear western style suits.
7. In 1941, he gave authority to the Ministry of Education to utilize the revenue and endowments of the pious foundation for non-religious instruction and allowed it to sell some of the lands to

provide facilities for educational purposes.

On the whole, most of the above reforms were directed towards the expansion of secondary and higher education. Rural and elementary education were neglected. However, this relatively low expansion of elementary education provided facilities for 15 percent of the country children to attend school. Table 2.1 shows some of the progress obtained in the growth of the elementary education. (9).

Table 2.1: A comparison of the growth of elementary school education in 1925 and 1940.

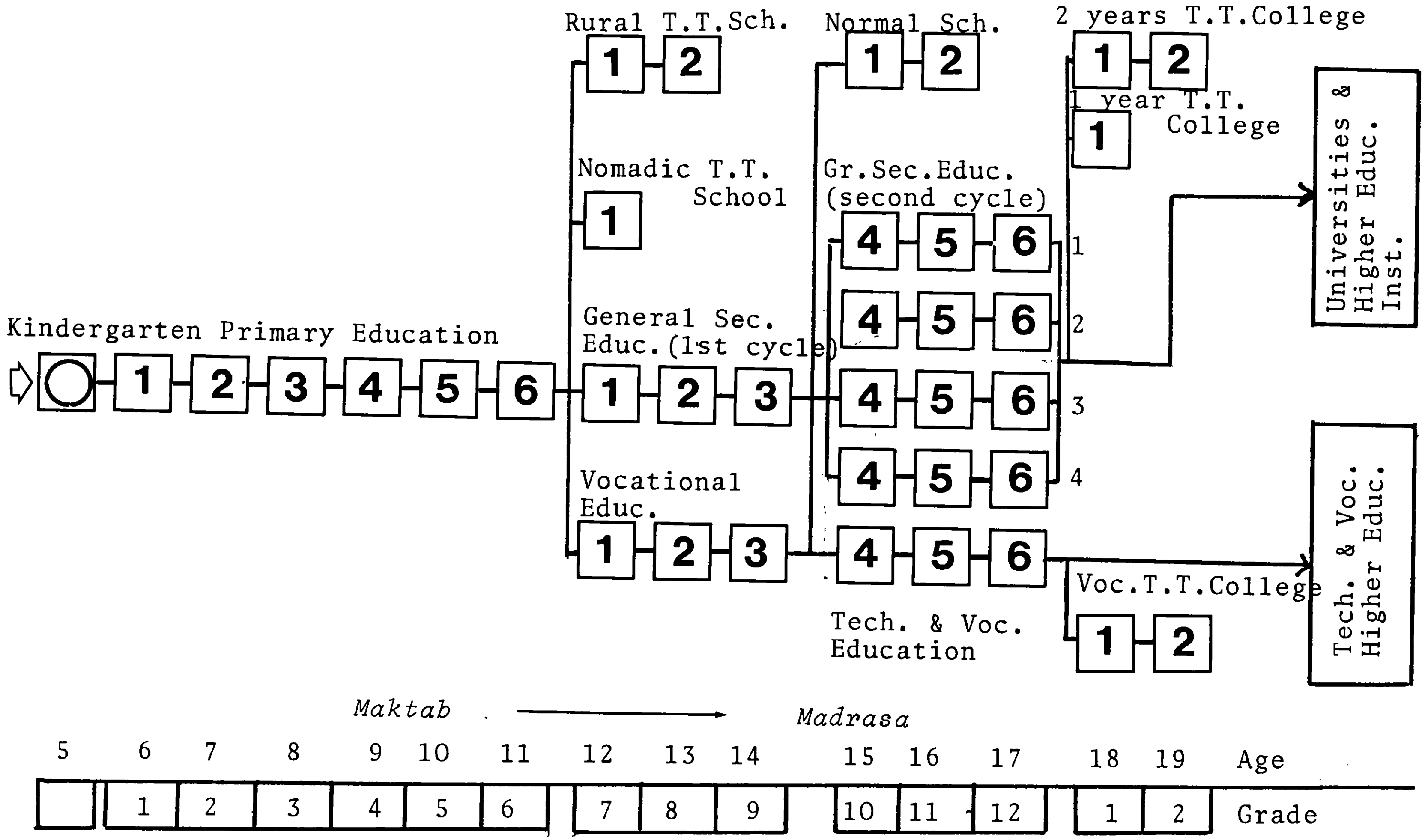
Year	No.of Schools	Total Enrolment	Graduates			Teachers
			Boys	Girls	Total	
1924-25	3,285	108,959	1,490	380	1,876	6,089
*1939-40	8,287	457,236	10,442	3,367	13,809	13,078
Approximate increase	2½ times	4 times	7 times	9 times	8 times	2 times

* Ministry of Education (1940) statistical yearbook. p.1. Tehran.

At this time some special institutions for training teachers were established: Normal school 1918, Teachers' Training College 1928, and Tehran University 1934. (10).

In addition to the above a number of technical schools and institutions were established and the existing institutions were expanded, the petroleum industry and communication improved, shortage of key personnel was satisfied by sending students abroad. Diagram 2.1 shows general pattern of this system of education that existed in this period of time.

Diagram 2.1: Old system of education - up to 1976.



Adopted from: Ministry of Education. (1976). Educational statistics. Tehran: Ministry of Education.

1. Mathematics 2. Literature 3. Natural Science 4. Home Economics

2.1.1 Elementary Education

The establishment of kindergarten was to acquaint children of ethnic groups to learn Farsi. (11). The primary education accepted children of the age 7. In the hierarchical 6 years of primary school a child studied (see Appendix 11, table 11.1):

Religious instruction (including Koran), Persian (dictation, composition and reading), history, geography, drawing, physical education, some social studies, music and a little singing, sewing and painting (for girls). (12).

At the fall of Reza Shah, religious instruction was reinstated in the school curriculum.

Children attended school five to six days a week. The school year used to run from the fifteenth day of the last month of the summer until the last week of the spring.

Every year at the end of the year a written examination was given in dictation, arithmetic, geometry, composition and handwriting. If the student passed the written examination, he took oral examinations and those who had passed could obtain the special certificate for the completion of the primary education.

In 1951 the number of primary students reached to 831,933, double the number of children in 1940 (13) and in 1960, 8.2% of the total population were at elementary schools. This ratio raised to 11.4% in 1970.

The dramatic difference between the ratio of children in primary school in urban and rural areas suggests that opportunity for this level of education is still very low in rural areas. Because of the effect of Islamic culture and early marriage of girls in villages, their drop-out rate is very high. (14).

In 1969/70 there was one teacher per 33 elementary pupils and the rate of passes at the sixth grade, in 1966-67, was 86%. (15).

2.1.2 Secondary Education

Secondary education, according to Diagram 2.1, is divided into two three-year periods called the first and second cycle.

In the first cycle all students follow a uniform curriculum consisting of the following subjects (see Appendix 11-a, Table 11.3):

Arabic, calligraphy, chemistry, drawing, foreign language, geography, handicrafts (for boys), history, home economics (for girls), hygiene, mathematics, natural sciences, Persian language and literature, physical education, physics and religious instruction.

Students who pass the examination at the end of the first cycle can continue in one of the three academic subjects (literature, mathematics, natural science) or at a normal school or any similar institution. However, choosing one subject is decided by the total average of the marks he had in that subject, in the last 3 years (usually 12 over 20).

In the second cycle the following subjects make up the curriculum (see also Appendix 11-a, Table 11.5):

Arabic, chemistry, drawing and technical training (for boys), foreign language, history and geography, home economics (for girls), logic and philosophy, mathematics, natural science and hygiene, Persian language and literature, physical education, physics, and religious and moral instruction.

The total number of hours per week is the same for all branches but different emphasis is laid on the study of individual subjects according to the subject specialization.

At the end of the sixth year students pass a national examination and obtain the secondary school certificate.

In 1971-72 there were 1,140,993 pupils at the secondary school and the annual budget was £24 per pupil. From the 100 pupils registered in 1965, only 36 students graduated in 1971-72. Most of the drop-out was at the 1st, 3rd and 6th grade. (16).

2.1.3 Teachers' Education

2.1.3.1 Primary School Teacher Education

Primary school teachers are mostly trained at the normal schools and agricultural schools. Sometimes, secondary school graduates or those who passed one year Teachers' Assistance Course are employed by the Ministry of Education to teach at primary schools. The two-year programme of the normal schools includes the following subjects (17):

Persian language and Persian literature, mathematics, chemistry, natural science, hygiene, psychology, principles of education, morals, short history of education in Iran, Arabic language, foreign language, history and geography, painting and drawing, music and songs, physical education, handicrafts, agriculture, teaching practice.

Since 1941, 110 normal schools were established. In 1975 there were 20,164 students (57% girls and 43% boys) at these centres. (18).

The normal schools are boarding institutes and used to attract the best students from small towns and rural areas. According to one study at the Ministry of Education the average parents' salary of most of these students is below £900 a year and they mostly live in rented houses where a separate rooms for each member of the family is not provided. (19).

The low salary of primary school teachers corresponds with their qualification. Their situations are best described by the Shah. (20).

"In our primary schools ... many ... teachers have ... never had the advantage of a proper education, either in subject matter or in methods ... learning by rote is still stressed rather than training the child to think for himself, to take responsibility, and to tell the truth. Our teachers ... find themselves handicapped by poor equipment. Their salaries are low, and often they have housing problems."

2.1.3.2 Secondary School Teacher Education

Secondary school teachers are mostly graduates of the National Teachers' Training College (N.T.T.C.) or faculties of education at universities. However, the shortage of teachers had forced the Ministry of Education to employ any graduate of universities or introduce one-year graduate study for graduates of science faculties.

In 1960, the low salary of the teachers caused a decline in the attractiveness of the teaching career so that many transferred themselves to other Ministries where their salaries were sufficient to support their families. Those who stayed had to find supplementary jobs.

The situation of the teacher's salary, ossified curriculum and teaching methods at higher education institutes, have created a teaching method that Shah has described as fairy-tale telling in the classroom. (21).

"In Persian language we have a word, *dastan*, which commonly implies something that is neither fact or fiction but lies somewhere in between. In the past much of our teaching of history and other subjects was in that spirit, and the student learned nothing of modern natural or social science ... too much of old *dastan* spirit lingers on even today; furthermore, we still over-emphasize uncritical memorization."

In fact, a teacher who had to teach more than 50 hours per week could not teach in any other way but to tell *dastan*.

2.1.4 Vocational and Adult Education

There are various types of vocational schools in Iran:

1. Rural vocational schools. These are primary schools which either teach vocational subjects and elementary curricula (22) or accept students who had finished their 3rd year of primary education and spend three years to learn agriculture or metalwork. The latter category is called rural schools. In 1960 there were 192 rural

schools all over the country. (23).

2. Amuzeshgah accept pupils graduated from primary school and in three years' time train them as skilled workers in a speciality vocational course. The standard curriculum of these schools is composed of the following subjects (24)(25): Book-keeping, chemistry, foreign language, geography, hygiene, mathematics, Persian language, physics, religion, shopwork, social sciences, sports, technical drawings, technical mathematics, and technical subjects (specialization).

3. Honarestan or technical schools are those institutions that accept students who have graduated from the first cycle of secondary school or have eight years educational background in primary and secondary level. The basic curriculum of these schools is composed of the following subjects: Mathematics, natural and experimental sciences, Persian and foreign language, religious and moral instruction and social sciences.
However, most of the weekly timetable is spent on the specialized subjects (26)(27).
There are five types of technical schools:
1 - Boys technical schools; 2 - Girls technical schools; 3 - Agricultural secondary schools; 4 - Business secondary schools; and 5 - Music schools. Sadiq (28) classifies normal schools in the same categories as the technical schools.

The graduates of vocational institutions mostly are absorbed in industry or recruited for higher education. Many choose the teaching profession. (29).

2.1.5 Adult Literacy

An adult literacy programme was started in 1955 by the Ministry of Education and Ministry of War to teach the 3 R's to soldiers and adults in rural and urban areas.

2.1.6 Some Other Aspects of the Old System of Education

The system of education described above is now called the old system of education. In that system there were certain characteristics:

The old system of education was fully developed as above by 1940. From 1940 to 1974 the system expanded quantitatively but ossified qualitatively (Table 2.2).

(A) In 1930 the increasing number of secondary school graduates were easily absorbed by the existing higher education institutes and bureaucracy. (30). Between 1940 and 1951 the number of these graduates tripled and rose from 287,245 to 650,355 students. At the same time the capacity of universities rose from 3,385 in 1940 to 5,502 in 1951.

This culmination of graduates of secondary education and the lack of jobs created an acute unemployment problem. Several programmes were created to solve this problem: a) to expand the capacity of the existing higher education institutions; b) to increase the number of higher education institutions; and c) to encourage them to study abroad.

Between 1950 and 1960 the number of students in foreign countries reached 30,000 - more than all students who had

Table 2.2: Educational index of Iran[1]

Year	Number of Institutions				Number of Students			
	Primary Schools	Secondary Schools	Technical Schools	Universities and Schools of Higher Learning	Primary Schools	Secondary Schools	Technical Schools	Universities and Schools of Higher Learning
1922	440	46	-	1	43,025	9,308	-	91
1932	1,186	156	-	3	141,103	13,120	-	602
1942	2,401	320	-	12	244,315	26,812	-	3,405
1947	3,209	314	-	18	386,266	37,866	-	6,257
1949	3,538	-	-	-	417,366	-	-	-
1950	8,612	308	-	-	756,683	44,585	-	3,624
1955	6,736	739	12	-	816,509	140,611	1,595	-
1960	9,809	1,183	83	-	1,436,169	281,928	9,348	-
1962	12,451	1,207	86	-	1,719,353	326,856	9,198	-
1965	15,135	1,559	109	78	2,181,633	493,735	15,224	29,683
1970	15,202	2,509	189	85	3,002,858	1,012,920	30,579	75,876
1972	15,902	2,925	277	118	2,862,596	942,523	56,795	98,377
1974	18,696	2,274	339	148	3,138,471	797,292	69,682	123,119

(1) Ganji, M. and Milani, A. (1976). Developments during the last 50 years. In: *IRAN, past, present and future*. p.45. New York: Aspen Institute.

graduated from higher education institutes in the previous 100 years (Table 2.3).

Table 2.3: Graduates of higher institutions in Iran, 1951-1968[1]

College	Graduates	Average No. of Graduates per Year
Dar-al-funun	1,100	28
Other colleges: 1901-1923	400	20
All colleges: 1923-1939	1,908	118
All colleges: 1939-1958	9,142	610
All colleges: 1954-1958	2,113	528
All colleges: 1958-1968	7,200	820
Total	21,863	

(1) Arasteh, A. Reza. (1969). *Educational and social awakening in Iran*. p.38. Leiden: E.J. Brill.

(B) The vigorous efforts of Reza Shah for centralization of every system created an unproportional expansion of the educational opportunities in the capital city of Tehran. In 1964, according to the Ministry of Education statistics (32):

32 percent of the nation's secondary school students were studying in Tehran.

34 percent of all Iranian literates lived in Tehran.

69 percent of all those who had any college education lived in Tehran.

73 percent of all university students in Iran were studying in the capital's institutions of higher education.

(C) The blind adoption of the French system of education to westernize the Iranian system of education created a university system which was alienated from the needs of the country.

Most of the innovation and reforms were neutralized by the adoptive policy and resistance of religious elites.

The revision of the school curriculum between 1940 and 1960 was mostly limited to the change of the sequence of the topics in the textbooks or addition of illustrations. The method of teaching was authoritarian and by rote memorization.

(D) The new bureaucrats trained under reformist system of Reza Shah showed a lack of co-operation with each other. They were working for their personal benefit, lacked any respect for the people and misused the government properties. (33). These characteristics at the Ministry of Education, and the incorrect philosophy of administration from the top, created a great gap between the administrators and the teachers. Another reason, which widened this gap, was the employment of decision-makers at the Ministry of Education who had lower qualifications than the teachers, or no qualifications for their jobs.

2.2 The Modernization Period

In 1963, Mohammad Reza Shah, the second shah of the Pahlavi dynasty, launched a 20 years programme for economic and social reform and political development of the country.

This programme - so called "White Revolution" or "The Revolution of the Shah and People" - started with six points or principles but until 1975, eleven other points complemented the previous ones (34):

1. Land reform (1963)
2. Nationalization of forest and pastures (1963)
3. Sale of government factory shares to support land reform (1963)
4. Introduction of profit-sharing system to factories and workshops (1963)
5. Reform of electoral law (1963)
6. Formation of literacy corps (1963)
7. Formation of health corps (1964)
8. Formation of development corps (1964)
9. Formation of equality courts (1964)
10. Nationalization of natural water resources (1968)
11. Reconstruction of the country (urban and rural) (1968)
12. Administrative and educational revolution (1968)
13. Expansion of ownership based on industrial manufacturing units (1975)
14. Price stabilization and campaign against profiteering (1975)
15. Free education (1975)
16. Provision of free nutrition and care for all children from birth up to the age of two (1975)
17. Provision of health insurance to general public (1975)

The points Nos. 6, 12 and 15 above concern directly the reform and modernization of education. However, for the first time, rural literacy became a national aim (point No. 6) and was supplemented by peasant liberation (point No. 1) and measures for their welfare (points Nos. 7, 8, 9 and 11).

The provision of "White Revolution" was facilitated by a series of development plans designed to develop different aspects of economy. The third, fourth and fifth development plan was especially concerned with education. The fifth development plan (1973-78) concentrated primarily on education and social reform, closely followed by reforms in industry and agriculture as the key areas for development. (35).

2.2.1 The New System of Education

The new system of education implemented in 1966-67 at the primary level and gradually, grade by grade, replaced the old system.

Diagram 2.2 shows the general feature of this system. The first eight years, compulsory and free education, is called "General Education". A student who passes the final examination of the elementary school, at the fifth grade, is given a certificate for completion of elementary education.

There is also a one-year course of kindergarten education which is, together with the first year of primary education, called "Preparatory Education".

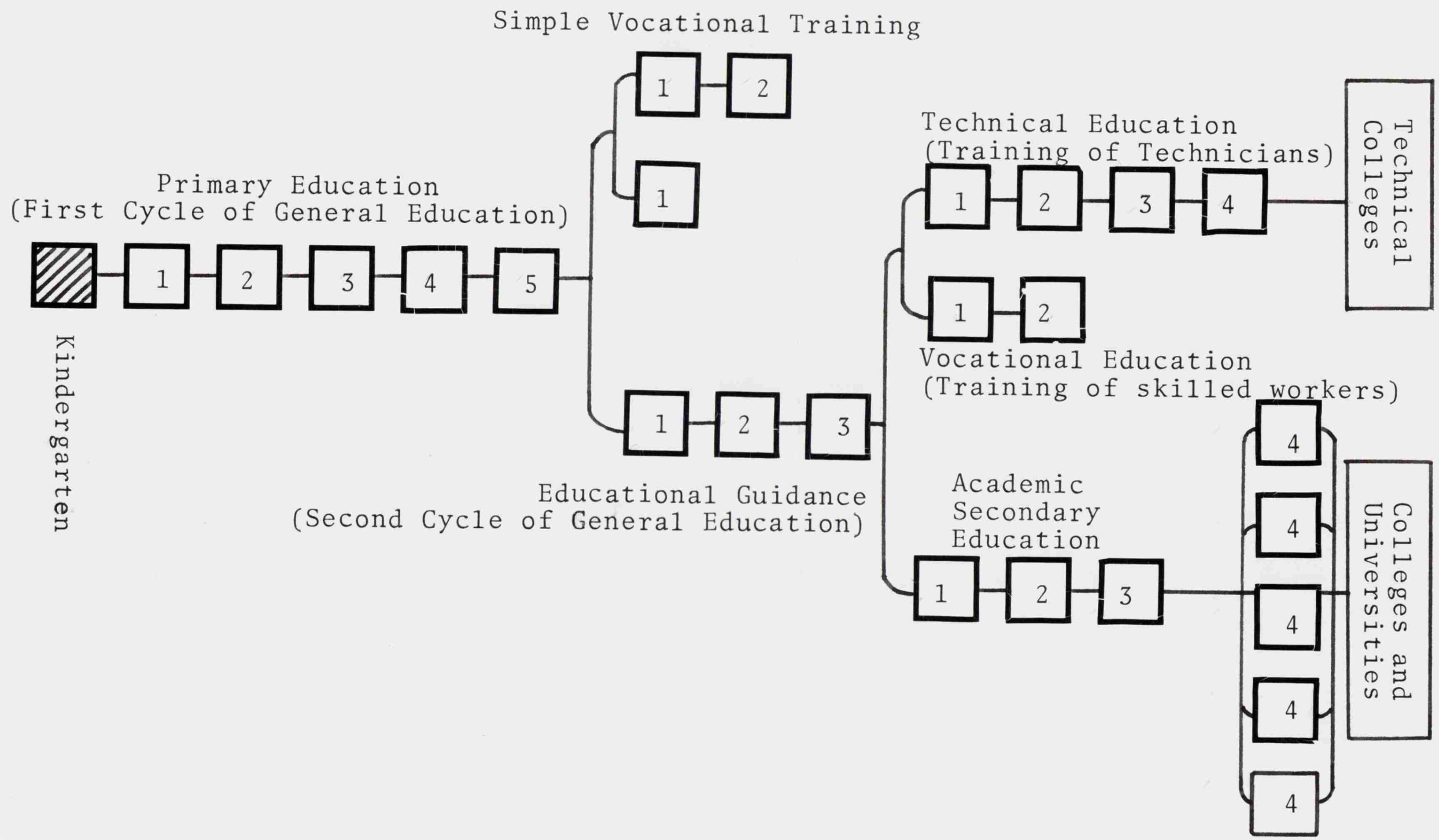
2.2.1.1 Primary Education

In 1975 primary education was considered as having two levels: a) first level of primary education, covering the first and second grade; and b) the second level of primary education, including the third, fourth and fifth grades. (36).

The curriculum includes the following subjects. (See also Appendix 11-a, Table 11.2.):

Persian, arithmetic and geometry, religious instruction, physical education and games, social studies, art and

Diagram 2.2: New school organization of Iran - from 1967.



Source:

Iran, Ministry of Education, "Preliminary Plan for the Improvement of National Education", *Op. cit.* p.10.

handicrafts, science and hygiene.

Details of this curriculum can also be found in Appendix 11.

2.2.1.2 Guidance Cycle

The "Guidance Cycle" is a new part of the new system of education which hopes: a) to increase general knowledge of students for better living; b) to develop moral and spiritual virtues; and c) to discover students' talent and interests for academic, comprehensive, vocational or technical studies at secondary education level. (37). The curriculum consists of the following subjects:

Persian language, mathematics, religious instruction, physical education, social sciences (history, geography and civics), arts (painting, calligraphy, sculpture and music), combined sciences (physics, chemistry, biology and hygiene), foreign language, introduction to technical and vocational education, Arabic.

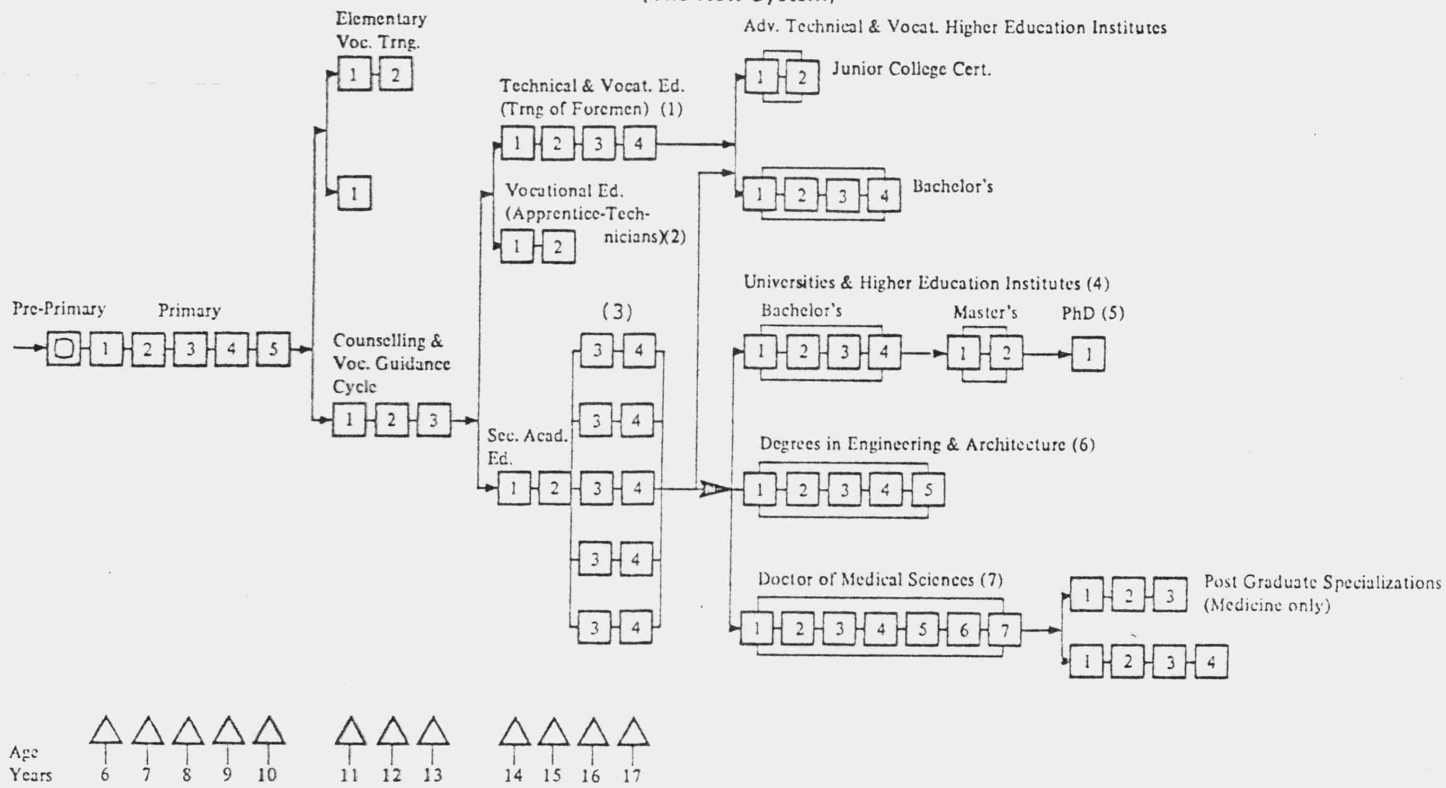
Details of this curriculum can be found in Appendix 11-a, Table 11.4.

At the end of this cycle, students take a national examination. On the basis of the results of this examination and those of the aptitude and intelligent tests and students' interests, students are directed to various branches of secondary education.

2.2.1.3 Secondary Education

In 1974 secondary education was divided into academic, vocational, comprehensive and technical schools. The first two years of secondary education was called the general

Diagram 2.3: The System of Formal Education in Iran 1974 and 1978 (1)
(The New System)



(1) This is equivalent to 2nd Degree Technicians (Assistant – Technicians).
(2) This course may be abolished in the near future.
(3) At present, 10 fields of specialisation are offered. These are: Mathematics: Natural Sciences; Literature & Humanities; Foreign Languages; Education; Economics; Sociology & Social Studies; Statistics; Nutrition & Home Economics; and Art. These fields are subject to changes as decisions are not finalized.
(4) These are average durations required for the completion of each level of study. These durations sometimes vary between higher education establishments.
(5) Docturate requires minimum period of 1 year and maximum period of 2 years.
(6) Possible to obtain degree equivalent to BSc after 4 years and MSc after 5 years at some Higher Education Institutions.
(7) Doctoral for Pharmacy; Dentistry; and Veterinary Medicine usually requires a minimum period of 6 years.

(1) Source: Watson, Keith (1975) *Op. cit.* p.24.

study cycle in which students who had not decided their future professions or studies could be exposed to varieties of subjects to help them in their decision. The second two years was secondary education in which specialized courses were taught (Diagram 2.3).

In 1975, the general secondary education consisted of a three-year course (see Diagram 2.2 on page 32). The fourth year was thought to be included in the higher education system to prepare their future university students as they wished. This suggestion gave rise to a hot debate between the Ministry of Science and Higher Education and the Ministry of Education.

The impact of this change was that the curriculum of the second year of general study was replaced by specialized courses and this period was reduced to only one year in time.

In 1975 system of education, the general secondary education in the academic and comprehensive schools was divided into two branches (38):

1. Experimental science and mathematics which divides into: a) physics and mathematics; and b) experimental sciences. (See Appendix 11, Table 11.6, for the details of the curriculum.)
2. Humanities divided into: a) literature and culture; and b) economic sociology.

The secondary technical education has three branches:

1. Technology, with 8 branches and 15 specialities.
2. Vocations, with 5 branches and 17 specialities.
3. Rural vocations, with 4 branches and 10 specialities.

Diagram 2.2 shows the general feature of this system.

In 1976-77 the above system of education was replaced by its early versions and the Ministry of Science and Higher Education and Ministry of Education were merged into a single Ministry of Education.

The most significant feature of the new system of education was the expansion of technical and vocational courses. The establishment of comprehensive education also helped the further expansion of these sections of secondary education. It was hoped that 90% of the students would be absorbed in the industry and non-academic courses. This strategy will decrease the number of candidates for higher education and eventually prevent the high rate of unemployment. Establishment of the new system of education was accompanied by the establishment and development and expansion of some organizations and quantitative development of the students population in all sectors.

2.2.1.4 Some Other Aspects of the New System of Education

(A) Organizations:

Following the introduction of the White Revolution, some educational institutes and organizations were established or re-organized to facilitate the development of the new system of education:

1 - Textbook organization, originally established as an American sponsored organization, Franklin Publication Institute, to revise and publish new textbooks for the Ministry of Education. This institute is now an independent organization within the Ministry of Education. Its supervisor is directly responsible to the Minister himself.

The establishment of the Textbook organization and the new system of education, terminated the monopoly of a few French-oriented authors and created opportunities for others to contribute in writing and creating new textbooks.

2 - Centre for the Curriculum Planning and Research, which was a non-functional office at the Ministry of Education, became an independent organization for curriculum planning and research for the Ministry of Education. Most of the technical details of the new system of education are prepared and supervised by this Centre.

3 - The Teachers' Training Department was expanded and concentrated on the normal schools and the Guidance Cycle Teachers' Training Centres. This department in 1976 was supervising 29 Child Instructor Centres, 110 normal schools, one Nomadic Teachers' Training Centre and 24 Guidance Cycle Teachers' Training Centres. The Department is in charge of the entrance examinations and the administrative and financial management of the Teachers' Training Centres. Table 2.4 provides comparative information on some aspects of teachers' training at this period of time.

4 - Centre for the Mental Development of Children and Adolescents, established in 1972, concentrates on children's mental welfare, running children's libraries, and encouraging the publication of children's literature. (39).

5 - The Educational Corps or Army of Knowledge was established to make the rural population literate. Young high school graduates, trained by a 4½ month's course at the Military Campuses, are sent to villages to establish primary education and help the peasants in their daily

Table 2.4: A comparison of teachers' training institutes in Iran.

	Institute	Minimum Entry Qualification	Years of Study	Institute or Level to Teach
1	Normal school and Tribal school	8-9 years of general education	2	Primary schools
				First cycle 1
2	Agricultural and Technical school	8-9 years of general education	2	Rural school
				Primary school
3	Guidance Teachers' Training Centre (G.T.T.C.)	12 years of general education	2	Guidance cycle
4	National Teachers' Training College	12 years of general education	4	Normal schools Secondary schools
			4 + 2 graduate studies	G.T.T.C.
5	Universities Faculties	12 years of general education	4	Normal schools Secondary schools
			4 + 2 graduate studies	G.T.T.C. and Higher Education
6	Universities Faculties	12 years of general education	4 + 2 graduate studies	Undergraduate levels
			4 + 6 graduate studies	All levels

1 - not after 1965

problems. In 1971, as a commemoration of 2,500 years of Iranian Monarchy, 3,200 schools were built by the finance contribution of public and private sectors of the society. (40).

The activities of the Literacy Corps have already spread to 50,000 villages. The following table (2.5) summarizes their achievements in their first decade (1962-1972):

Table 2.5: The achievement of Literacy Corps in 1962-1972*

Kind of Achievement	Quantities
1. Schools (built)	15,208
2. Schools (repaired)	25,432
3. Mosques (built)	3,043
4. Mosques (repaired)	17,743
5. Mortuaries (built)	1,557
6. Mortuaries (repaired)	3,332
7. Feeder roads made (in Km.)	143,806
8. Bridges	52,193
9. Water systems	24,673
10. Trees planted	3,851,503
11. Public baths	7,495
12. Sanitation wells	78,098
13. School desks and chairs	34,116
14. Post-boxes installed	7,322
15. Parent-Teacher Associations	24,505
16. Boy Scouts and Girl Guides	173,384

*Ayman, I. (1974). Educational Innovation in Iran. *Op. cit.* p.22.

This list shows the wide range of activities of the Lieracy Corps in addition to literacy.

6 - Correspondence Courses and Free University. The increasing numbers of secondary education graduates seeking higher education, and the shortage of qualified teachers,

made the establishment of correspondence courses at the Ministry of Education run by the National Teachers' College for the Army of knowledge. And, Free University by the Ministry of Science and Higher Education in 1975. The latter institute is using the Educational Television and Radio intensively.

7 - Department of In-Service Courses at the Ministry of Education was established in 1974 and ran various in-service courses at universities and higher education institutes for the teachers of the new and old systems of education.

8 - The National Teacher Training College (N.T.T.C.) was given university status and became independent from the Ministry of Education. (41). This institute expanded its organization and established new branches in state capital cities. The objective of this institute is training secondary school teachers and running various post-graduate courses needed for administrative jobs at the Ministry of Education.

(B) The quantitative development of students population:

The establishment of the new system of education and the implication of the 17 points of the White Revolution, particularly the Land Reform, created new dimensions in the Iranian system of education:

1 - The population of the urban and rural areas, specially the young generation, increased due to the improvement of health organization. In 1966, the population was 25.7 millions. It increased at the rate of 2.8% to 3.3% between 1965 and 1975, producing a population of 33.3 millions in 1975, with 45.5% under the age of fifteen years. (42).

2 - The land reform and literacy campaign provided more opportunities to the rural population to have access to formal education. The rapid expansion of urban areas and the job opportunity persuaded many people to emigrate to bigger urban localities. A glance at the statistics of the different levels of educational systems reveals this trend. Since 1963, there is a sudden increase in the numbers of students at the 1st, 3rd and 6th grades of the secondary schools in the urban areas, and decrease in the rural school population.

3 - The fact that a higher certificate is decisive in finding a job with higher salary and status, made secondary and higher education more attractive for lower and middle class people. Specially they understood that the trend in the new system is to divert students from academic schools which lead to higher education. Therefore, it was not surprising to find out that the overall growth of secondary and higher education institutes was more than that of the primary schools level (Table 2.6):

Table 2.6: Overall expansion by level 1962/3-1972/3[1]

Level	Enrolment (000s)		Annual Growth	Growth % Overall
	1962/3	1972/3		
Kindergarten	13	24	6.3	84.0
Primary	1719	3424	7.2	99.0
Secondary (Gen.)	327	995	17.0	380.0
Secondary (Tech.)	12	66	18.7	450.0
Higher	24	83	16.2	350.0
Literates	2900	8250	15.0	184.0

(1) Adopted from: Watson, K. (1976). The Shah's White Revolution education and reform in Iran. *Op. cit.* p.28.

However, in spite of the massive campaign against illiteracy, the rate of illiteracy is 35% in urban areas and 85% in rural areas, an average of 50%. (43).

Therefore, in spite of the change in the system of education, the machinery that Reza Shah started still operates to produce more graduates.

4 - The rapid expansion of the new system of education, the introduction of the unfamiliar syllabuses and the allocation of the same teachers who used to teach in the old system, increased the rate of drop out. (44).

Tables 2.7 and 2.8 provide a comparative data of the rate of drop out in the old and new systems of education:

Table 2.7: The rate of drop out in the old system of education between 1966/67 and 1974/75 [1]

		Primary Education					Guidance Cycle			Sec.
Sex	Area / Grade	1	2	3	4	5	1	2	3	1
Boys	Urban	174,254	95	88	86	80	72	55	47	38
	Rural	183,528	88	77	68	56	18	12	10	3
	Total	357,782	92	82	77	67	45	33	28	20
Girls	Urban	145,254	93	87	86	73	60	50	45	37
	Rural	62,189	79	66	56	48	15	10	8	3
	Total	207,443	89	81	77	60	45	38	34	27

(1) All the figures except for the first year are in percentages.

Table 2.8: The rate of drop out in the old system of education between 1966/67 and 1974/75[1]

		Primary Education						First Cycle			Sec.
Sex	Area / Grade	1	2	3	4	5	6	1	2	3	1
Boys	Urban	161,179	96	89	87	87	80	107	106	107	86
	Rural	172,395	87	79	69	65	52	28	24	22	7
	Total	333,574	91	84	78	76	65	68	63	62	45
Girls	Urban	134,360	93	87	85	85	71	78	76	77	62
	Rural	565,080	78	65	57	50	46	16	12	11	4
	Total	190,940	88	80	76	74	64	59	57	57	45

(1) All the figures except for the first year are in percentages.

The above tables indicate that:

(a) Educational opportunities for boys in rural areas is far more than for girls, since girls marry at early ages and have privileges in the society at large and in rural areas in particular.

(b) The rate of drop out in the new system of education, especially at the guidance cycle, is very much higher than the old system of education. This is partly due to the newness of the system and imposition of various changes and the factors discussed above. However, the population of boys shows a surprising amount of gain in the old system of education which is due to the immigration of newly literate youngsters from rural areas to the urban areas. In 1970, with the announcement of the establishment of the Guidance Cycle, the middle class population who were not sure about the future of the new system rushed their children into the old system.

(c) The highest rate of drop out is found after each final examination. This is true in both systems with different degrees of effects.

5 - The improvement ~~of~~ in the economic situation, due to the increase of oil revenue, provided financial support for free education. The fifth development plan (1973-78) projected an annual growth rate of 15.3% G.N.P. per annum, which was revised to 25.9% G.N.P. in 1975. In 1976 this rate was 50% per annum. (45).

6 - The change of social class system, after the White Revolution, was towards the reinforcement of the system developed at the Safavid dynasty (see Figure 1.1). The ruling elites allocated certain international schools for their children or preferred foreign education in the later decades. The Court school was established to give special training to the Crown Prince and his future nuclear elites. The reformist policy of Reza Shah and the revival of the glory of the past were reinforced. The centralization of all the government departments and every aspect of state affairs intensified the alienation of bureaucratic employees from their jobs. The change in the new system of education was continuously being influenced by the decision of the Monarch and its rapid changes prevented a coherent management and curriculum development.

2.3 Summary

The above analysis shows the effect of some factors in the development of the Iranian system of education:

1. The political leader, and what is in his mind about the role and function of education and modernization, is very crucial in the way the educational system develops.

   Reza Shah's ideology of the role of education in modernization was very limited. His system created a machinery to supply particular skills within society.

   His successor, Mohammad Reza Shah, has basically followed the same reformist policy but made a moderate effort to make the long~~ly~~ neglected peasant literate. His main objective of the use of education in modernization is to provide the manpower needed for the fast expanding industry in the country. According to his repeatedly announced ambition, he hopes that "the country will achieve in a generation what it took Japan a century to do, namely to become one of the world's most powerful industrialized nations by the late 1980's." (46).

2. The emphasis on vocational and technical education was the result of the above ideology. It is true that a rapid and self sustaining growth of modern industry must be widely adopted and be utilized, therefore a wide range of skills must be taught in modern schools. But limiting and simplification

of the scope of productive capacity of education as the supply of particular skills within the society, as projected by the new system of education in Iran (47), is questionable.

3. The system of education, both old and new systems, created a greater number of graduates who had no choice but to compete for a higher education degree.
4. Both systems neglected the teachers' education. The quantitative expansion of the Teachers' Training Institute did not decrease the shortage of qualified teachers. It is estimated that the present shortage is 57,000 teachers. (47).
5. The bureaucratic system based on certificates rather than achievement criteria and the particularities of the social situation had created a high rate of "brain drain" in both systems. This is not favourable with the shortage of manpower required for higher education institutes.
6. The rapid change in society, and the anomaly in decision making and directing the trends of change, have reinforced the influence of the religious elites. The increasing number of Islamic schools in recent years is the reaction towards rapid westernization supported by the government.

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CHAPTER THREE

BIOLOGY CURRICULUM DEVELOPMENT IN IRAN

Modernization of the Iranian system of education is mainly the result of socio-economic development and the implementation of five seven-year plans during 1945-1978. In the following summary the main educational characteristics of this period are discussed with special reference to the development of the Biology curriculum. Greater emphasis will be made on the new Biology curriculum of the first year of the secondary school - the Ecology curriculum in particular. Firstly, the effect of B.S.C.S. and Nuffield biology project on the new biology curriculum is outlined.

3.1 Historical Background of Iranian System of Education

In 1851 when Darolfunun was established, the French system of education became a model for curriculum development and textbooks. The Ministry of Education and the system of education was modelled on the basis of this system, according to the understanding and interpretation of the political and educational elites. As the result, the system of education that developed could not fulfil the socio-economic development of the country but could only educate the most able students for the need of bureaucratic manpower. This elitish system of education consisted of Islamic schools and Darolfunun. The Islamic schools at this time gave 6 years of elementary education. Darolfunun would accept students at the age of 11 or 12. It was a mixture of secondary and higher education. (1).

The deficiency of the Islamic schools in training students in science, mathematics and other modern sciences meant that they were not qualified to continue their study at the Darolfunun. This led to the opening of secondary education institutes. In time, higher educational institutions upgraded themselves, as the system expanded.

The role of education was always to provide manpower for the army and bureaucracy. With the expansion of education, the aim became to create a unified and united country.(2). It was this latter aim which subordinated educational system under political and economical development.

Between 1911 and 1945 three American financial missions studied the problems of developing the Iranian socio-economic system. The second and third missions, headed by Dr. A.C. Millspaugh, conducted a comprehensive study of the Iranian system as a whole and educational system in particular. This report reflects some of the historical reasons which affect Iranian system of education today. (3).

Dr. A.C. Millspaugh in his first mission concluded that the financial problems of the Iranian system were the result of socio-political status. Unless a social and political reform could take place, the educational system could not be improved. And, as the result of this, the manpower for solving Iranian financial problems could not be educated. (4).

In his second mission the same theme was emphasised. (5). However, at this time (1946), when the first seven-year plan was in the process of implementation, several other reports on the educational system were prepared. The most important amongst them was the Overseas Consultant Inco. (O.C.I.) report on Iranian system of education. This report was specially prepared for the Iranian government to facilitate educational planning of the future. (6).

O.C.I.'s report on the Iranian system of education is very pessimistic. Several areas are blamed for the stagnation of the system:

1. Iranian linguistic and ancient heroic traditions.
2. An attachment to a feudal agricultural system and its socio-economic implication.
3. The poetic and cultural tradition.
4. The religious and moral values of Islam.
5. The tradition of French education as adopted by Iran in the 19th century.
6. The high rate of illiteracy and the educational gap between rural and urban areas. (7).

To improve the system, the O.C.I. report suggested decentralization of the system of education, campaigns against illiteracy, land reform and change of attitude of the political elite toward the socio-political situation. It also rejected the continuation of the distorted French system of education and advised that an Anglo-Saxon model be used to encourage independent thinking and create critical attitudes in students towards whatever they are learning.

The effect of extreme centralization, in the view of the O.C.I. report, had been dramatic on educational opportunities and the role of teachers and students in the system of education:

1. The highly centralized system has created highly centralized administrative bodies. This concentration of power, automatically shifted allocation

of resources to centre and state capital cities. Therefore, educational opportunities are immense and local needs and requirements are ignored.

2. The central control on curriculum and textbooks creates a situation in which indigenous cultures and languages are ignored. The curriculum becomes alienated from local requirement.

3. The control of the promotion of the teacher, on the basis of their obedience towards administrators, has discouraged teachers from using their initiative to act according to their local needs and class requirement. As the result of this behaviour, and due to rigid and authoritative curriculum and instruction, a generation of children who are taught to obey rather than think independently and critically, were created.

4. The above elitist system of education was not only the result of the conditions discussed above but also due to inefficiency of the teachers' training and higher education. These institutes had no link with industry and the reality existing outside their boundaries.

In 1963, following the land reform, a new system of education was planned. This system was implemented in 1967 and replaced the old system of education gradually. Other socio-economic reforms followed.

The most important aspect of the new system of education was the change of the aims of education. (8). These aims, according to the "Preliminary Plan for the Improvement of Education", are as follows:

1. Social aim: to extend equal educational opportunities to all Iranians in accordance with their aptitude and talents, and to provide free and compulsory education of 8 years' duration.
2. Economic aim: to train skilled workers, technicians, engineers, experts and competent administrators for the management of the economy of a developing country. To achieve this aim it is necessary to change peoples' attitudes towards practical and moral work. The curriculum of the new system will combine theoretical studies with practical work.
3. Political aim: to educate the youth for active participation in political and social life of the country. The new system will inculcate in young people the values of co-operation, respect for law, freedom and responsibility, and acquaint them with individual rights, in order to enable them to discharge their duties to the state properly.
4. Cultural aim: to activate and develop artistic abilities of the youth not only for the sake of personal happiness but also for enriching Persian art and civilization.
5. Physical development aim: to provide adequate physical education facilities for all in order to have a strong and healthy population.
6. Ethical aim: to help the youth to acquire a

positive social and ethical philosophy in line with the fundamental principles of the "White Revolution" and the spiritual, moral and religious values of the nation.

In the light of these aims, the educational system will be based on a set of new principles. Briefly, they are:

1. Access to free primary education to all Iranian youths irrespective of their socio-economic background.
2. Provision of educational facilities for the most talented and gifted youth at all levels; and extension of technical and vocational education free of charge as far as possible.
3. Provision of the best type of education for the greatest numbers in accordance with their talents, and the socio-economic needs of the country.
4. Diversification of curricula in response to individual differences, and provision of special education for handicapped children.
5. Provision of guidance facilities in schools.
6. Introducing all pupils to practical and vocational subjects in keeping with the national development plans in addition to general subjects.
7. Educational programmes will be geared to social and economic needs of the country and market demands.
8. In designing courses of study in general and specialized education, the physical, mental and

psychological development and condition of the children and the youth will be taken into consideration.

9. As the new system of education should be, in the first instance, geared to socio-economic needs of the nation, and because of the importance of vocational and technical education, attempts will be made to train the youth for practical work as well as to develop their creative and artistic abilities. To attain these goals, theoretical and practical subjects will be taught side by side in schools.

10. Education in its broad sense will have priority over training. In other words, the physical, mental, emotional and moral development of children precedes training and instruction.

11. In order to encourage the majority of the youth to pursue vocational and technical courses, the new educational system will be organized in such a way to facilitate access to higher technical schools, technical colleges, and evening courses.

12. Educational institutions will be in constant contact with the economic organizations and scientific institutes, in order to improve educational standards, and bring about changes in teaching methods and curriculum construction.

13. Curricula will be designed with due regard to the differences in customs, culture and the socio-economic needs of various regions.

14. Throughout the country children will be taught to respect ancient traditions, customs, past glories and the principles of the "White Revolution".
15. Teacher-training programmes will be improved.
16. The youth shall be helped and guided to make proper use of their leisure time and engage in useful and rewarding activities.
17. The Ministry of Education, as the overall leader of the educational system, shall co-ordinate all the educational programmes at various levels, while decisions on administrative details shall be delegated to the local offices and provincial departments of education.

In the new system of education most emphasis was laid on the expansion of the technical and vocational and comprehensive education. It was projected that the progression of the new system will limit the population of academic secondary education to 5 percent of the total secondary students. (10).

The expansion of the system of education provides a need for varieties of science curricula - particularly biological curricula - in the new system of education for its different grades.

In 1975, the system of education described in the "Preliminary Plan for the Improvement of the Education" was revised. (11). In the new revision, four pilars are suggested:

1. Language and culture.
2. Environmental studies.

3. Technology.

4. Mathematics.

By environmental study it is meant that a student should understand his environment and analyse the phenomena involved in its development and changes. History, geography, social studies and economy, ecology were mentioned as examples for such an enquiry. (12).

At the secondary level it is recommended that three branches should operate: a) humanities; b) experimental sciences; and c) technical sciences. The curriculum of each should cover 60 percent of the specialized subjects and 40 percent of other subjects. e.g. In experimental science a student opts for 60% of his subject from experimental sciences, 20% from technical science and the rest from humanities science. (13). This policy is adopted to reduce the number of subject matters involved in the curricula.

Finally the report recommends that reform in teaching and learning at higher education is necessary. And, higher education should educate qualified teachers, researchers and specialists. (14).

3.2 <u>The Biology Curriculum Development in Iran</u>

There are four stages in the development of the Iranian biology curriculum and textbooks. In the first stage the French model for curriculum and textbooks is laid down. In the second stage this model is modified and diversified to suit the new development in the school organization. In the third stage new curricula for the specialized courses at the secondary schools are developed. Finally, in the fourth stage, a new biology curriculum and textbooks replaced the traditional ones.

3.2.1 Stage One 1852-1914

Establishment of Darolfunun, in 1852, revived the idea of teaching and learning science and mathematics as an integrated part of the school curriculum activities. Since these subjects had been abandoned for three centuries, they had no equivalent in the Islamic educational institution. They had to be imported from a foreign country. The rivalry of interests of the English and Russian governments lead to the adoption of the French curriculum and textbook for science and mathematics. At the Darolfunun these subjects were taught by French and Austrian professors who were accompanied by an Iranian counterpart. His function was to translate the lesson and provide notebooks for the students' exercises. (15).

The need for scientific textbooks gradually lead to the establishment of a translation office and the involvement of Iranian graduates from foreign countries, in writing and translating. In time, when Darolfunun students graduated, they joined this movement and controlled not only what was to be taught in science but also how it should be taught.

Islamic schools were quick to realize the importance of science and mathematics syllabuses in their school curriculum. By 1914 most of these schools had "Natural Sciences" or "Natural History" in their curriculum.

The words "natural sciences" were applied to a multidisciplinary course which contained all sciences dealt with by Nature. For example, Motarjem Homayun's book

Natural Sciences, 1878, (16) covered topics on the human body, astronomy, physics, geology, chemistry, mineralogy. Agasaid Birjandi's book *Natural Sciences*, 1901, (17) had topics on geology, physics, chemistry, anatomy, animal classification and hygiene. These examples show that there was no proper definition for natural science and all subjects related to natural environment could be included in the curriculum and textbook.

The curriculum planning was exercised by a committee at the Ministry of Education whose aims were to educate the most able students. Textbooks were formal and lacked experimental activities. The curriculum was rigid and authoritarian, and the method of learning was rote memorization. Even the few experiments in the text were learnt in the same way. The textbooks were translated from foreign languages. They had a contents table and a few factual questions at the end of each chapter. The role of the teacher was authoritative and the method of teaching was verbal and by lecture. The role of the students was passive and their task was to memorize facts from the instruction without critical thinking about their validity.

3.2.2 Stage Two 1914-1938

During this period of time, a secondary education was gradually introduced into the system of education. The primary school curriculum for natural science maintained its traditional definition and status. The establishment of secondary and teachers' training institutions, introduced new curricula and textbooks for science and mathematics.

At the end of this period the biological sciences were defined as zoology, botany and physiology. The imitation of the French system of education for the establishment of 6 years of primary and 6 years of secondary education (18) led to a rigid and authoritarian curriculum. Methods of teaching and learning were the same as the previous stage. Curricula were translated from the French system without scrutinizing the values and traditions behind each curriculum.

3.2.3 Stage Three 1938-1962

In 1938 the secondary education was divided into two cycles. In the second cycle boys could take the academic programme and specialize in either literature or science; girls took the general course or the normal one. (19). The change in the secondary education was accompanied by the establishment of the Tehran University in 1934 (20) where courses in educational and behavioural science were started for the first time.

In 1938 a group of scientists were invited to develop curricula and textbooks for science courses. These books, which were printed by the Ministry of Education, were better known as "Ministry of Education textbooks". They consisted of 80 volumes and were prepared in three years. (21).

These books were printed on the best paper. They all had hard covers and their language of instruction was formal and too advanced for the secondary school level. However, their contents were up-to-date and comprehensive. The "Natural Science" was defined, according to these textbooks, as zoology, botany, physiology and geology. Here are some titles of the "Ministry of Education textbooks":

1. Sheibani, A., Forutan, G. and Bahrami, H. (1940) *Zoology.*
2. Sahabi, Y. and Mirhadi, A. (1940) *Geology and Evolution.*
3. Golegolab, H. and Parsa, A. (1940) *Botany.*

In the course of curriculum development a member of a group who believed evolution is best studied as a part of paleaonthology imposed his idea on the committee and the Ministry of Education. This unfortunate imposition persisted in the Iranian biology curriculum at secondary and university level for years. In 1972, by the introduction of the new system of education and the retirement of the professor mentioned above, the subject of evolution was returned to the biology textbook.

The professors involved in curriculum and textbook preparation were all the founders of Iranian science faculty at Tehran University - and science and methodology courses at the National Teachers' Training College. Since all biology teachers between 1940-1965 were students of these scientists, their idea of biology teaching and learning is influenced by the concept of curriculum development the above professors were propagating in their class discussions.

Between 1942 and 1962 the change in the curriculum and textbook was limited to the change of the authors involved. In 1958 local teachers were invited to prepare textbooks on the basis of the Ministry of Education syllabuses. In 1965 a uniform textbook was allocated for each grade and the Book Organization at the Ministry of Education became the sole body for preparing textbooks for educational institutions. It worked under Ministry of Education supervision.

At this stage the school curriculum became uniform all over the country. Textbooks were only improved in terms of their paper and the use of colour pictures and bindings; but, the same traditional, rigid and formal curriculum was followed. (22). Educational opportunities were still greater in urban areas and 60% of the children had no access to the educational facilities. The universities system was not offering necessary and efficient education to train students for higher professional jobs. Methods of teaching were outdated and authoritarian. The role of the student was passive.

3.2.4 Stage Four 1962-1978

In 1963 the preliminary plan for the improvement of national education was discussed. In 1966 this plan was approved and in 1967 the first year of the new primary education was implemented throughout the country. (23).

In the new system of education there are 5 years of primary, 3 years of guidance cycle and 4 years of secondary education. (24).

In the new primary school curricula, "Natural Science" is about the immediate natural environment of children. (25). The curriculum emphasises scientific attitudes towards observation and problem solving. Experiments are simple, practical and require little effort to set up. This subject covers topics from plant and animal classification, physiology, anatomy and environmental science.

At the Guidance Cycle level science is taught through a combined science curriculum which is a translation from a series of American textbooks. (26). The main goal of the curriculum is the achievement of scientific enquiry by the experimentation and problem solving. The role of the student is considered dynamic and he is encouraged to question the validity of teachers' instruction, conduct, project works etc.

A biology curriculum by its definition was introduced for the first time in Iranian system of education at the first two years of the secondary education. This curriculum was the result of a biology curriculum planning group established in 1970 by the Curriculum Research and Planning Centre at the Ministry of Education. This committee is called the "First Biology Curriculum Committee" from now onwards to differentiate it from the "Second Biology Curriculum Committee" which was involved in curriculum planning for the last two years of the secondary education.

3.3 The New Biology Curriculum

The first biology curriculum committee studied the status of biological teaching and learning in the old system of education. It reviewed the university teachers' training system and studied biology curricula in western countries. Then it drew its attention to the change of the aims of the system of education and studied the implication of recent socio-political and economical developments in the country.

The General Director of the Curriculum Research and

Planning Centre outlined the following criteria for the biology curriculum:

1. The curriculum is for the students of age group 14-16 who have succeeded in their study at the Guidance Cycle. These students may, or may not, have chosen their future professions. Therefore, they are at a transitional stage.
2. The main aim of the new system of education is to direct 95 percent of students to vocational and technical schools. It is hoped that only 5 percent of students would be absorbed by academic schools. Therefore the biology curriculum might be the last instruction they receive in this subject. It should provide information they will require in their future life.

In the light of the above criteria the committee categorized the following additional rationales for the biology curriculum. (27).

1. The land reform and the nationalization of natural resources - rivers, forests, steppes, and so on - made it necessary to protect and conserve the national state of these resources.
2. Rapid industrialization of the country created, and continues to create, many problems. Foremost amongst these is that of pollution of the environment.
3. Improvement in the communication system produced a high mobility of population within the country. This was accompanied by the establishment of car

factories and a sudden economic boom. These developments provided better holiday opportunities, mechanized agriculture and immense immigration and emigration. People are constantly moving and working in new surroundings and situations.

4. In a vast country like Iran, with an arid climate, green vegetation is limited to the area where there is sufficient precipitation. Hence preservation of the existing green area is vital, especially in towns. This feature is now more critical because of the rapid expansion of urban areas which threaten the suburban villages. The walled gardens are being swamped with houses and the number of immigrant peasants to industrialized cities increases.

5. Natural vegetation such as desert shrubs and charcoal has been used extensively for fuel purposes, but as the availability of oil products spreads, people should become aware of this, so that the consuming of these plants can fall into disuse.

6. It has been predicted that due to a wide variety of opportunities - in terms of agricultural schools etc. - only 5% of the student population will have an opportunity to study biology in future. These youngsters at the age of puberty are faced with mental and physical problems of their age and require specific biological knowledge.

7. The neglected subject of evolution has been misplaced in the old system of education. This subject proved to be very interesting for students of this age group and provides a valuable contribution towards understanding biological literature discussed in their future life.

Having described the above criteria for curriculum rationale the committee decided to include the following subject matters or topics as a means to reach the goals and objectives of the experimental sciences. (See Appendix 1 for the details of this curriculum.) (28).

(A) Ecology

(B) Hygiene

(C) Reproduction

(D) Genetics

(E) Evolution

The Committee defined two specific objectives for the biology curriculum:

1. Understanding similarities and diversities amongst organism in nature.
2. Understanding the status of man in the living world. That he is a living organism with similar functions and has close relationship with other organisms on the earth. (29).

The method of instruction was defined as experimental rather than verbal, and the role of the student was defined as an active one.

In 1973, the first volume of this new biology curriculum was published and was implemented throughout the country -

for the first year of the Academic and Comprehensive schools. In this book (30) ecology and hygiene were discussed in two separate sections. The Ecology section covers the following topics:

Section one - the web of life

Chapter one - Autotrophism. This chapter contains photosynthesis, chemosynthesis, comparison of photo-synthesis with chemosynthesis, energy economics in living creatures.

Chapter two - Heterotrophism. Considers digestion and synthesis.

Chapter three - Ecosystem and its Structure. Examines structure of ecosystem.

Chapter four - Functions of Ecosystem. Is a study of energy flow, nutrient cycle, succession.

Chapter five - Population as a Unit of Ecosystem. Considers density, factors affecting population density, population changes, growth and equilibrium, problem of human population.

Chapter six - Interactions within Ecosystems. Includes competition, symbiosis, predation.

Chapter seven - Aquatic Ecosystems. Is a study of some general characteristics of aquatic ecosystems, marine ecosystems, fresh-water ecosystem.

Chapter eight - Terrestrial Ecosystem. Is a study of tundra, coniferous forest, deciduous forest, tropical forests, grassland, desert, man and terrestrial eco-systems.

Section two is about mental and physical hygiene and first-aid instructions.

Each chapter in the Ecology section has some experiments which are integrated parts of the content material, plus a series of questions acting as "self assessment" tests to emphasise the main objectives of the chapter, and some "activities outside classroom" which are additional experiments, projects, and suggestions for further activities. At the end, there is a list of references for further study about the topics discussed on the chapter.

In the 1975, and especially 1976, editions, the content and sequence of this book has undergone various changes, details of which are discussed in Appendix 4 of this thesis.

The second year book contained the following organization. (31):

Unity in the web of life:

Chapter one - *Cell, the structural and functional unit of living organism*. Includes cell theory, structure of cell, cells.

Chapter two - *Chemical structure of the living organism*. Is the study of water and minerals, organic compounds in the living things.

Chapter three - *Reproduction and growth*. Is a consideration of mitosis, asexual reproduction, sexual reproduction, various methods of sexual reproduction, reproduction in man, growth, parental care, old age.

Chapter four - *Genetics of living creatures*. Is a study of historical genetic development, genetic and m~~y~~tosis, study of some of man's characteristics, pure and hybrid, some other genetic patterns.

Chapter five - *Evolution of living organisms*. Is about mutation, study of changes, natural selection, present view on natural selection, effects of environment on the evolution of living creatures, adaptation and survival.

Chapter six - Evolution of man. Explores the early man, human races, the human animal!, the present man.

This book had questions at the end of each chapter for self-assessment and problem solving, reference for further study and activities outside the classroom.

The biology curriculum developed by the first biology curriculum development committee became a universal model for the new secondary education, particularly the first year curriculum on ecology. (See discussion below.)

In 1973 when vocational secondary school - branch hygiene - required an ecology curriculum for training nurses, a modified version of the biology curriculum was implemented and its textbook was published in 1974. This book was organized as follows (32):

Chapter one - the web of life. Includes food chain, food web, needs to energy and materials, cycle of materials, eco-system and its effective factors.

Chapter two - Producers. Is a study of methods of nutrition in producers, varieties of producers.

Chapter three - Consumers. Considers methods of nutrition in consumers, varieties of consumers.

Chapter four - Decomposers. Is a study of methods of nutrition in decomposers, varieties of decomposers.

Chapter five - Terrestrial ecosystems. Is a study of tundra, coniferous forests, deciduous forests, grasslands, desert.

Chapter six - Aquatic ecosystems. Considers some of the characteristics of the aquatic ecosystems, marine ecosystem, fresh-water ecosystem.

Chapter seven - Man and ecosystems. Is a study of man and changes in ecosystems, pollution.

This small book was based on the specific objective of the biology curriculum and was mostly related to the needs of the first year of students who studied the vocational branch of hygiene.

In 1975, when the expansion of academic schools was forced upon the system of education, there was a need for a biology curriculum for the first year of the secondary school - branch humanities. The same model of curriculum was modified to suit the requirement of these students. The 1976 textbook of this curriculum contained the following chapters. (33):

Section one - Ecology

Chapter one - The web of life.

Chapter two - Population.

Chapter three - Interaction amongst populations.

Chapter four - An ecosystem and its structure.

Chapter five - Producers and consumers.

Chapter six - Aquatic ecosystems.

Chapter seven - Terrestrial ecosystems.

Chapter eight - Man and the change of ecosystems.

Section two - Diversities in living organisms

Chapter nine - Diversities in the web of life.

The first section of this book was identical to the 1974 edition of the biology curriculum for the first year of academic secondary education. The second section contained plant and animal classification.

The study time for each of these books was two hours per week (except that for the branch hygiene which was one hour per week).

The above discussion illustrates how the first year biology curriculum diversified for the use at various branches of the secondary school. The model of curriculum development showed a flexibility for such developments.

3.3.1 Biology Curriculum for Specialized Courses

In 1974 the organization of secondary education changed into one year General course and three years Specialized secondary education. (34). By implication of this system the second year of the general course was only implemented for one year and it was replaced by a new curriculum.

In 1972-73 a second Biology Committee was established to consider the biology curriculum for the second two years of the secondary school. The aim of this curriculum was to provide a specialized biology course for the academic and comprehensive schools.

In this committee, the majority of the members were scientist-biologists of different disciplines. However, representatives from Science Teachers' Association, Book Organization and from Curriculum Research and Planning Centre had participated. There was also a biology methodologist from the Faculty of Education.

After several weeks discussion the committee decided on the following criteria as the rationales for curriculum planning:

1. There should be one principle called the Science of Biology for the whole curriculum.
2. An up-to-date and comprehensive syllabus should be prepared to cover most of the principles in biological science which could be relevant for the secondary school.
3. An evolutionary approach should be applied for the method of presentation and instruction.
4. Discussion of plant and animal classification should be kept to a minimum to facilitate the understanding of diversities and similarities of organisms discussed in the curriculum.
5. Structure and function should be discussed together to fulfil the rationale no.3 above. (35).

The committee did not accept the necessity of defining curriculum objectives prior to curriculum planning. To them it was clear that the only way to prepare secondary school students for the university courses was to reflect theories and methods of modern biological science in the classroom. Therefore the most important question was what kind of material should be put into the content of the curriculum and what sequence they should follow to preserve the unity of the biological enquiry.

After 18 months the committee produced details of curriculum content which included a list of suggested experiments for appropriate sections. (36).

Introduction

Chapter one - What is Biology?

<u>Section one - Cellular and chemical basis of life</u>

Chapter two - Chemical basis of life

Chapter three - Cellular basis of life

<u>Section two</u> - <u>Biological activities of the living creatures</u>. Study of structure and function.

Chapter four - Nutrition

Chapter five - Gas exchange

Chapter six - Transportation of materials

Chapter seven - Discretionary system and the regulation of the internal environment

Chapter eight - Chemical regulation

Chapter nine - Neutral regulation

Chapter ten - Behaviour

Chapter eleven - Locomotion and movement

<u>Section three</u> - <u>Survival and continuity in living creatures</u>

Chapter twelve - Reproduction

Chapter thirteen - Growth

Chapter fourteen - Genetics

Chapter fifteen - Evolution

Chapter sixteen - Ecology

<u>Section four</u> - <u>Origin of life, diversities of living creatures</u>

Chapter seventeen - Origin of life

Chapter eighteen - Diversities of living creatures

The first and second sections were planned to be taught at the first year and the rest at the second year of the specialized secondary education. Six hours per week was considered to be sufficient for teaching the above curriculum over two years.

In 1974 the second year of the general secondary education was abolished and the secondary education became one year of general secondary and three years of academic, specialized courses in experimental science, mathematics, humanities. (See chart on page 83.)

This revision of the secondary education disrupted the programme of textbook production. In 1976 a temporary book was hastily compiled by book organization experts in order to give students a resource for study. In 1977, when the first volume of the Secondary Biology was printed, it was allocated for the second year of the old general secondary and another temporary textbook was prepared for the last year. In 1977 the first biology textbook was transferred to the third year. It is hoped that in 1978-79 the whole matter will be settled down.

However, the first and second biology curriculum committees both emphasised to the establishment of in-service courses, the necessity of preparing teachers for the new curricula. The discussion of the in-service courses is followed in the text below.

3.3.2 Dissemination of the New Biology Curriculum

The first biology curriculum content contained subjects like ecology and genetics, human reproduction and development, and evolution, which were all new in teaching and learning biology at the secondary school level.

The teachers had no background in ecology but the other topics had been studied in their undergraduate courses. Therefore the first biology committee recommended two important issues prior to implementation of the biology curriculum in schools (37):

1. A teacher's guide should be prepared parallel with the development of student's textbook. This was to help the teacher in understanding the aims and goals and objectives of the new system of education and biology curriculum.
2. A short-term in-service course should be established in local areas to provide opportunity for the curriculum developer and the textbook authors to discuss methodology, objectives, and other new criteria implemented by the biology curriculum.

The book organization did not accept the first suggestion but argued that the teachers themselves should feel the necessity of a teacher's guide and recommend it to the Ministry of Education. When this happened, however, in all the seminars and in-service courses, the book organization was too busy to produce another book at a time when it had so many at hand for the new vocational and technical and academic schools.

However, the second suggestion was welcomed by the Department of Secondary Education at the Ministry of Education. Several local classes took place in which teachers were briefed about the curriculum. To up-date teachers' knowledge a series of lectures on ecology and hygiene were given by specialists.

The first biology committee, in its study of the status of biology teaching and learning in Iran, noticed that the teachers of the Guidance Teachers' Training Colleges had been teaching ecology from a B.S.C.S. textbook. It was suggested, to the Ministry of Education, that these teachers could act as local key persons to follow up in-service courses for the teachers, provided Science Teachers' Associations could be established to make use of the local central laboratory facilities.

The process of dissemination of the first year biology was more or less smooth: except for the misunderstanding of the secondary school administrator and the newness of the subject matter, it followed the pattern indicated.

The second biology committee was aware of the difficulties of the biology teachers to implement the new curriculum. It prepared a detailed programme for in-service courses in which 70 percent of the course was allocated for theoretical background, 10 percent for methodology and 18 percent for experimental activity. (38). These courses were conducted by the University Biology Department and members of the committee took part.

In summary, the dissemination of biology curriculum in the new system of education was conducted by university elites. They developed the curriculum and prepared the text, they directed in-service courses to disseminate their concept of curriculum development in the secondary school institutions. The differences between the first and second committees were as follows:

1. The first committee based its curriculum development on the basis of research and modern concept of curriculum planning and development.

2. It tried to disseminate its curriculum rationale in in-service courses and laid emphasis on the method of teaching rather than the content of the curriculum. Content was described as a means for achieving curriculum objectives.

The second committee believed that once an up-to-date content, with few experiments, could be taught, the theory and methodology of biological science will be understood. This philosophy, for curriculum planning and development, was disseminated in the in-service courses and the lecture method with occasional teachers' experimentation was advised as the method of instruction. The committee was not explicit on the role of the learner. However, it believed the above conditions would automatically interest and motivate students for practicing an active role.

3.4 The Effect of B.S.C.S. and Nuffield Biology Projects on Iranian System of Education

In Iran the dissemination of the B.S.C.S. and Nuffield Biology projects did not start at the secondary school level, as was the case in other countries.

In 1970, when Djondi-shapour University at Ahwaz, was re-organizing its science faculty curriculum, a few Iranians, with American educational background, thought that the implementation of the new American science projects at the first year of undergraduate study would up-date students' knowledge and prepare them for university education. To implement this programme, a complete set of laboratory equipment and materials were ordered and the textbooks were translated into Farsi.

In the case of biology, the B.S.C.S. Green version was selected. This text and its relevant laboratory activities were used at the first year to prepare undergraduates for advanced courses in biology at the later years. This programme was gradually changed and was eventually replaced by different university science courses.

Between 1970 and 1973 a selection of B.S.C.S. and Nuffield 'O' level experiments were used by the author at the National Teachers' Training College as an integrated part of the methodology course. In 1973, when the author was transferred to the Faculty of Education at the Tehran University, these experiments were widely used in under- and post-graduate courses in methodology of teaching biology.

In 1971, Guidance Teachers' Training Colleges were established and the immediate problem was to develop a science curriculum that would not repeat secondary school science curricula but would up-date students' knowledge. At the same time, a science teacher who was familiar with the progress of implementation of the American science curricula at Gondishapour University, received the post of the General Director of the Guidance Teachers' Training Department. She implemented the American science textbook (now in Farsi version) as the curriculum and the textbooks of the G.T.T. Colleges. Following this programme a series of in-service courses was established in the summers of 1971-1974 to acquaint teachers with methodology of the teaching and show them how to carry on experimental activities.

However, four British science teachers were commissioned to plan and conduct these in-service courses. As the result, most emphasis was placed on Nuffield science project experiments and dissemination of knowledge about their equipment and materials. This strategy eventually lead to the order of complete sets of Nuffield 'O' level equipment and materials, in 1973, for the G.T.T. College laboratories.

In 1974, some of the Nuffield 'O' level experiments, as well as the Scottish version of this curriculum, was used in the textbook of the first biology book for the secondary education. In the same year the curriculum of Normal schools underwent several changes. For the biology curriculum an adoption of B.S.C.S. Yellow version was used to prepare the primary school teachers to teach the biology section in the "Natural Science" curriculum.

The above incidents shows the B.S.C.S. and Nuffield Biology, due to their different nature of enquiry, achieved a different status in the Iranian system of education. The B.S.C.S. text was used as a source for up-to-date knowledge in areas that were not familiar for the biology teachers. However, the students found the American style of presentation of material strange, childish and somehow difficult to memorize. They were applying for their old curricula. The distracting factors were unfamiliar American fauna and flora. Since no laboratory activities, project works were accompanied by this book, the text was inefficient in fulfilling its goals and objectives.

In 1975 the B.S.C.S. text and other American science textbooks were removed from the G.T.T.C. curricula since, by the implication of the new system of education, there was no justification for their study.

Nuffield Biology was introduced as a source of simple experiments. These experiments were used at university level for methodology courses and in the secondary science curricula as examples for experimental activities. This status of the Nuffield Biology was the result of the way it was first introduced in Iran and of the way textbooks are heavily based on experimentation.

3.5 Summary

The Table 3.1 provides a summary of the characteristics of the four stages discussed above. The following are other important issues discussed in the chapter:

1. Before 1951, the most common educational institutions in Iran were Islamic schools. The period of study in these schools was 8 years. Darolfunun, a technical college in modern definition, was established to train Army officers and manpower needed for bureaucracy. This elitist concept of modern education and the adoption of a French system of education, lead to the establishment of a system of education which consisted of 6 years of elementary and 6 years of secondary education. In 1936, the last 3 years of the secondary education - second cycle - changed into specialized courses in natural sciences, mathematics and literature branches.

Table 3.1: Some characteristics of the four stages, in the development of the biological education, in the secondary education in Iran.

Stages / Characteristics	Stage One 1852-1914	Stage Two 1914-1934	Stage Three 1934-1962	Stage Four 1962-1978
Educational Institution	Maktab, Madrasa Darolfunun Modern schools	Maktab, Madrasa Primary and Secondary schools	6 years of primary 6 years of secondary Higher educ. institutions	5 years of primary 3 years of guidance 3 years of secondary Higher educ.
Innovation(s)	Introduction of Science and Maths curricula	Teacher Training Secondary educ.	Quantitative expansion. Uniform curriculum.	Reform in education. Emphasis on technical educ.
Biological Sciences	Natural Sciences: Phys. + Chem. + Bot. + Zool. + Geol. + ... + etc.	Natural Sciences: Zool. + Bot. + Physiol.	Natural Sciences: Zool. + Bot. + Physiol. Geol. + Evol.	Biology. Ecology.
Curriculum development	Foreign textbooks.	French textbooks.	Curriculum Committee + French textbook.	Curriculum Committee + Original textbooks.
Role of the Teacher Method of Teaching	Authoritative Lecture	Authoritative Lecture	Authoritative Lecture	Authoritative Mixed
Role of the Student Method of Learning	Passive Rote learning	Passive Rote learning	Passive Rote learning	Active Rote + Discovery method

The system evolved in the above way, was extremely centralized. Curriculum was rigid, authoritative and method of instruction was verbal. The role of the teachers and students was passive. Method of learning was by rote memorization.

2. In 1963, following several socio-political reforms, a new system of education was planned. This system was implemented in 1967 at the first year of primary education and replaced the old system of education in the coming years. The new system of education consisted of 5 years of primary, 3 years of guidance cycle and 4 years of secondary education. There are academic, technical and vocational secondary educations. The introduction of comprehensive education was an innovation in this system. The important aspect of the new system of education was the change of the aims of education.

Pre-1962, the concept of biology was not defined in modern views. It applied to zoology, botany and physiology. Evolution was, as the result of the influence exercised by an educational elite, studied in geology courses.

The concept of curriculum development, in the adoptive period between 1951-1962, was restricted to the content of textbooks which were translated from foreign languages. No curriculum planning was taking place.

3. After 1963, the biology curriculum planning became the job of curriculum specialists. Curriculum rationales were defined. Goals and objectives of the new curriculum were elaborated. A content was selected to facilitate achievement of the defined goals and objectives. Method of instruction was explicitly discussed and became experimental. The role of students and teachers became active. However, the above planning procedure was not a universal practice.
4. The ecology curriculum of the first year of the general secondary education proved to be versatile. It was used as a model for adoption of ecology curriculum for other branches of the secondary education and students of the same age group. Up to 1976, three versions of this curriculum were developed

   Specialized biology curriculum for the secondary education was comprehensive and all biological principles were discussed under one title - "Biology". This curriculum has undergone various changes since.
5. The B.S.C.S. and Nuffield Biology project played a constructive role in the Iranian system of education. The translated texts of the Green version and the Yellow version were used consequently as the curriculum and the textbook of the G.T.T. Colleges and Normal schools. The progress of the new system of education, specially the

appearance of the ecology curriculum, lead to the termination of their use. However, these texts were useful tools for disseminating biological knowledge.

The Nuffield biology textbooks were used as a source for experimental activities. Some of these experiments were even used in the new biology textbooks.

6. Dissemination of the biology curriculum in Iran was directed by a group of educational elite who planned the curricula, wrote the textbooks and conducted in-service courses by means of the various departments at the Ministry of Education.

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CHAPTER FOUR

RATIONALES FOR CURRICULUM EVALUATION

The role of evaluation can be defined as decision making or judgement about the effects of curriculum innovation. In a changing society, curriculum innovation is a factor of change. It interacts with values in the society and its educational system. As these values change the curriculum changes.

This view was not shared by the curriculum evaluators before 1960. The implementation of several curriculum projects faced evaluators with various situations which required various decisions and judgements about the curriculum effects.

It was soon realized that the effect of innovation was not limited to the student's attainment of a set of pre-specified objectives. Students do not learn in vacuo. There are several other variables inside and outside the curriculum which affect the student's learning.

In the last twenty years, several models for curriculum evaluation have been developed to deal with various specific situations existing in different curricula. As the result of this development, several techniques and strategies were tested, developed and used.

4.1 Rationales for Curriculum Evaluation

Most of the new ideas in curriculum evaluation are the result of implementation of several curriculum projects in the U.S.A. and Great Britain. During this time, the role of the evaluator was well defined and an evaluation programme became an integral part of curriculum development. (1).

There are certain universally accepted goals and roles of the curriculum evaluation which have been used in most of the projects; where goals were not prespecified, a different strategy was used to investigate the process of curriculum development.

Therefore, one could distinguish two general models for curriculum evaluation and several variations for each one:

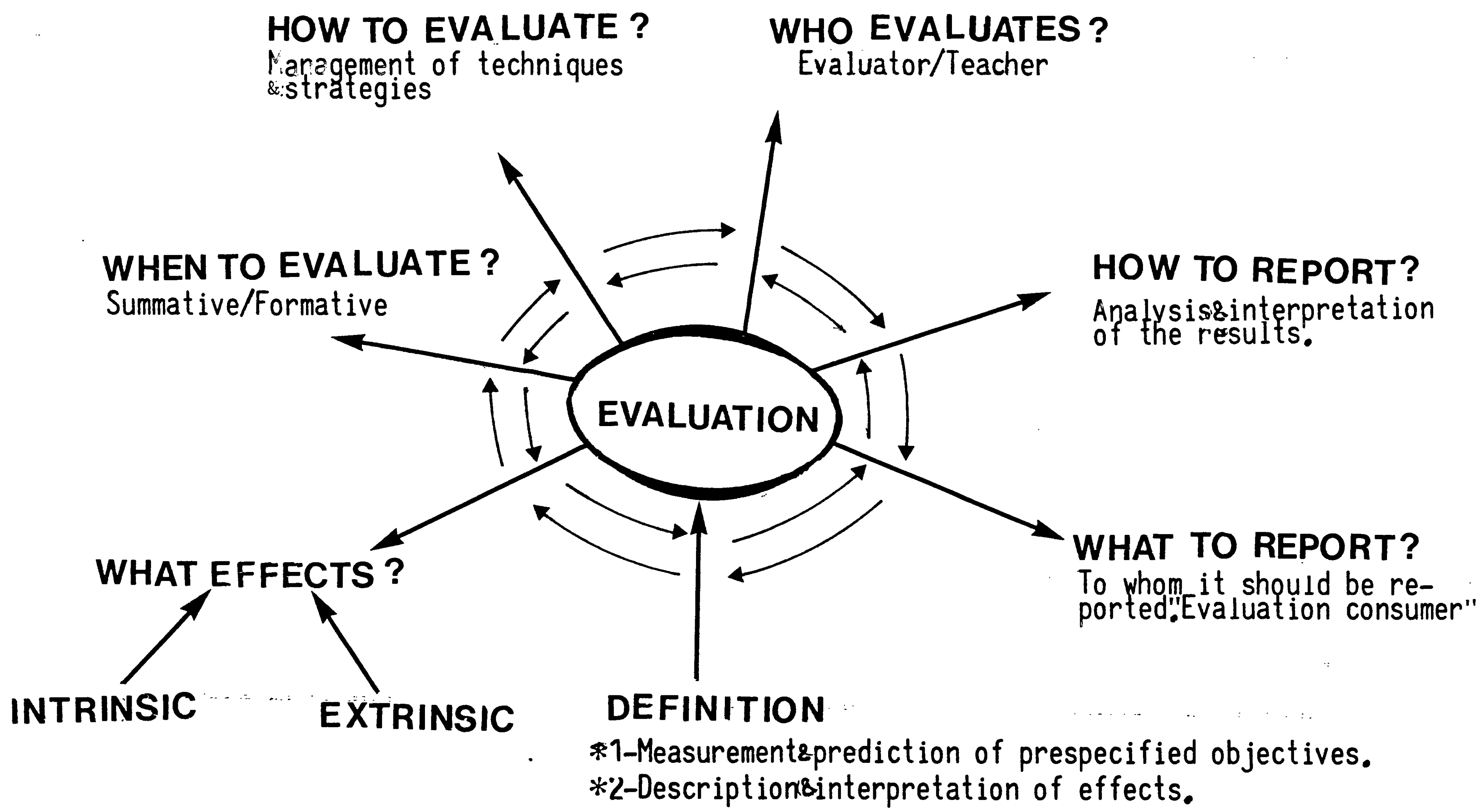
1. Goal-attainment model is concerned with the measurement and prediction of students' attainment in terms of prespecified objectives.
2. Illuminative evaluation model, which is concerned with description and interpretation of curricular effects.

In the development of the evaluation models several questions served as guidelines for evaluative studies (see Fig. 4.1). Each of the above models provide different answers to these questions. In the following some selective aspects of the above models of curriculum evaluation are discussed in view of these questions. However, for the sake of continuity and fluency of the discussion, no attempt was made to use the above questions as substitutes.

4.1.1 Goal-attainment Model

This model has been the most popular model for curriculum evaluation. Educational aims, in a goal-attainment model, are extracted from three sources: a) the students, the society and the subject matter; b) the psychology of learning; and, c) a philosophy of education. It was assumed

Figure 4.1: Some pertinent questions in curriculum evaluation programme. Evaluation programme can be started by answering any of these questions and continuing the process around the circle.



that there was a set of prespecified goals and objectives for curriculum evaluation. The evaluation of students' achievement of these objectives provides evidence as to which objectives have been attained and which have not been attained. The attained objectives were interpreted as the result of the effectiveness of the curriculum and instruction, method and media used. The unattained objectives provided evidence for the deficiencies of the curriculum which should have been attained, revised or rejected. (2).

From the debate between those who strongly believed in the application of behavioural objectives in curriculum development and those who opposed their use (3), several shortcomings of the goal-attainment model were revealed:

1. The emphasis on the specification of objectives created several effects. From a practical point of view, it was not clear to what extent specification should be carried out. On the other hand, a long list of highly specified objectives made them difficult to implement in a teaching and assessment programme. There were time, cost and other limitation factors for their assessment.
2. The fact that a curriculum is a changing element was deliberately neglected in this model. It was assumed that once curricular objectives were specified, the role of evaluation was mainly to provide information for the revision of instruction which would eventually lead to a better attainment of the objectives by the students.

3. The emphasis on quantitative data, obtained by objective means, led to the neglect of information about other effects which could have been useful to guide the curriculum developer and other decision makers about the effectiveness of the project.

It was due to the above criticisms that, in the later variations of the goal-attainment model, study of other effects were included in evaluative studies. In time, the term of evaluation was used for the total process and the measurement and assessment for specific ones.

In the early models, study of other variables were recommended to be carried out to serve as supplementary data for course improvement. (4). In later models a comprehensive list of all the possible instructional and institutional variables which might affect the outcomes of innovation was listed (5) and distinction was made between the discrepancy of the observation and prespecified objectives. (6).

These developments indicated that, although the main role of the evaluation is the judgement about students' attainment of the prespecified objectives, direct exposure to curriculum creates secondary effects in teachers who teach the programme. The effect of the curriculum may also extend to other students, other teachers. The role of curriculum evaluation is the judgement of the worth of all of these effects. It followed that two kinds of evaluation are required for the study of these effects: (7).

1. Intrinsic evaluation, which is concerned with the evaluation of the curriculum itself, curriculum

content, goals and teachers' attitude etc., and:

2. Extrinsic evaluation, which evaluates the effects of other variables.

The goal-attainment model for curriculum evaluation has a built-in strategy. It involves seven stages in curriculum evaluation (8):

1. To establish broad goals or objectives.
2. To classify objectives.
3. To define objectives in behavioural terms.
4. To find a situation in which achievement of objectives can be shown.
5. To develop or select measurement techniques.
6. To collect student performance data.
7. To compare data with behavioural stated objectives.

This strategy is carried out by the application of experimental designs (9) which involve testing and evaluating a hypothesis.

Most of the new curricula, implemented after 1960, had a trial stage on a small scale, to improve various aspects of its structure, before implementing them at a larger scale. These characteristics and the question of cost and effect raised other questions in curriculum evaluation.

It was generally agreed that evaluation of the curriculum in the trial stage provides feedback about deficiencies in the instruction for course improvement. It was suggested (10) that this evaluation should be best carried out by the curriculum developer. However, when the curriculum was implemented, an outside evaluator, who was not informed about prespecified objectives, should do the evaluation studies so that an unbiased evaluation of all the intended and unintended outcomes could be obtained. If, however, the prespecified objectives were attained then the project was judged as being successful. (11). This later view was not shared by all evaluators.

The above discussion indicates that the evaluator could be a teacher, a curriculum developer or an outsider who is familiar with educational research and evaluation. It follows, also, that their functions and the way they report their data, are different since they have different status and work for different employers.

As the result of the development of social sciences, and the application of their methodologies in educational research, non-experimental design has become accepted in goal-attainment models. In one of the earlier models a distinction was made between formal (objective) and informal (subjective) evaluation. Then, it was recommended that both forms of evaluation should be carried out to obtain a more comprehensive data about the process of the curriculum development. (12).

In later models, attention was mostly paid to the evaluation of the effect of the management and the process of decision making in curriculum development. For example, in the C.I.P.P. model (C.I.P.P. stands for Content, Input, Process and Product) evaluation was defined as the process of delineating, obtaining and providing information for judging decision alternatives. (13). In this model four kinds of decisions: a) planning; b) recycling; c) structuring; and, d) implementing may lead to the collecting of data for four kinds of evaluations:

1. Content evaluation.
2. Product evaluation.
3. Input evaluation.
4. Process evaluation.

The content and input evaluations determine planning decisions for selecting objectives. Process evaluation starts when objectives are implemented. Product evaluation serves recycling decisions to judge and react or reject data obtained about students' attainment.

In this manner decision making and management interrelate to each other.

It is quite clear that the four kinds of evaluation reflect intrinsic and extrinsic evaluation discussed earlier above.

The importance of the C.I.P.P. model is that curriculum evaluation is considered as an on-going process which helps improvement of instruction.

4.1.2 Illuminative Evaluation Model

This evaluation model is concerned with description and interpretation of curriculum effects. The task of evaluation activities is considered of providing a comprehensive understanding of the complex reality (or realities) surrounding the innovation. In short, to illuminate (14) the process of the development of the curriculum innovation.

Illuminative evaluation originated from a curriculum situation in which prespecified objectives were not available or deliberately were ignored. The use of non-experimental designs, in illuminative evaluation, is considered to provide more valuable data for understanding the process of the curriculum development, when analysed efficiently.

Illuminative evaluation mostly studies a generalized educational attainment, teachers' performance and expectations and the effects related to the function of and interaction between administrative bodies, the curriculum developers and other teachers on the curriculum development.

There are three stages in illuminative evaluation strategies:

1. Observation. In this stage the evaluator observes the institutional system and learning milieu to detect the problematic areas as well as investigation of the relationship and development of the phenomena.
2. Selection. In the second stage a number of problematic areas are selected for intensive investigation.
3. Description and Interpretation. In this stage general principles underlying the project are described. Every pattern of cause and effect within the project operation is monitored and described. Then students' attainment and other individual findings are described in a broad explanatory context. Also, an alternative

interpretation of the process is provided.

In this model the evaluator is considered to be an outsider or a member of the curriculum committee who prepares his evaluation model for professionals or governmental bodies.

The data collection techniques, in illuminative evaluation, mostly consist of: a) observation; b) interview; c) questionnaire and test data; and, d) documentary and background information.

4.2 Curriculum Assessment

The development of various evaluation models leads to the use of various experimental and non-experimental designs. Several instruments and techniques become the most common ones for data collecting, since they provide a more reliable and valid result. At the same time, development in educational statistics and research provides more refinement in these instruments and techniques. In the following, some of the most commonly used instruments and techniques in curriculum evaluation, are discussed.

4.2.1 Curriculum Analysis

Curriculum analysis is a technique for evaluating data about the intrinsic worth of the curriculum. Both curriculum analysis and intrinsic evaluation study documentary evidence from the curriculum. But, curriculum analysis has a wider scope of study by providing empirical evidence obtained from the curriculum as well. It consists of certain questions and rules to provide information for describing various aspects of the curriculum and makes judgement about their worth.

There are several curriculum analysis schemes, i.e. S.S.E.C. (15), Berkeley (16), Eash (17), Sweden (18), Sussex (19) etc. These schemes are either based on a model for curriculum evaluation or have combined different criteria to provide a comprehensive analysis of the curriculum involved. Some schemes, such as Eash (20) and Hussler (21), emphasize behavioural objectives. In the Sussex scheme this part is omitted to pay attention to the other aspects of the curriculum analysis which could be more useful for in-service training of the teachers. (22).

Curriculum analysis leads to a summative or formative assessment of the materials in use. It provides useful data for test development.

4.2.1 Questionnaire and Interview

There is certain data that the curriculum evaluator would like to obtain by asking questions rather than observing or testing a bit of behaviour. Questionnaires and interviews are two techniques which facilitate this kind of enquiry. They can also be used to discover what experience has occurred or is occurring at the present. This information is translated into quantitative data by using a check-list, attitude scale, rating scale etc. (23).

In curriculum evaluation, study of the following areas provides relevant information for constructing a questionnaire or a structured interview:

1. Interview with students, teachers, etc.
2. Study of the curriculum materials.
3. Study of the goals and objectives.

4. Study of the areas where sufficient data is not available.

Some of this information may be provided by curriculum analysis. Usually interviews provide useful information for constructing a questionnaire. They could also add valuable data after the completion of the questionnaire to validate some of the data being obtained.

Most questionnaires consist of several kinds of instruments, some have only one purpose and consist of one type of instrument. The choice between multi-purpose or mono-purpose questionnaires and the type of instruments is correlated with research limitation, and the objectives of the evaluation study.

In the goal-attainment model of curriculum evaluation, questionnaires and interviews are constructed to collect data or prespecified goals and objectives. In the illuminative evaluation model a survey type of questionnaire supplements the data and information that were missing from interview and questionnaire.

There are several standard textbooks about how to construct a questionnaire and how to develop structured or unstructured interviews. (25). The important factor in using these techniques is that in asking a question from a respondent we may influence his behaviour and therefore invalidate the results. On the other hand, interviews require a trained interviewer and allocation of time. It is an expensive process but provides extensive opportunities to ask questions about areas about which specific information is required. A Questionnaires also require lots of time and manpower resources for their preparation. Its results may suffer from the effect of non-respondents. However, it is less affected by errors and provides varieties of factual and non-factual information in a short period of time.

4.2.3 Attitude Scales

One of the important effects of curriculum innovation is its effect on students' and teachers' attitudes.

The problem of assessing attitudes by paper-and-pencil is that it is only a reflection of the reality existing in real life. Different kinds of attitude scales for assessing different types of attitudes have been developed for curriculum evaluators. The most popular attitude scales are those that have been developed by Likert, Thornstone, Guttman and Osgood.

The development of an attitude scale requires a large pool of items and a target population. There is a need of several judges and the application of sophisticated statistics to establish its reliability and validity. And yet, the result is not always satisfactory. (26).

Osgood's semantic differential technique is nowadays more popular since it evaluates attitudinal change in an indirect way. The scale consists of several bi-polar forms of words, i.e. good-bad, cruel-gentle etc. and respondents are invited to rate each item against the scale. This method requires a knowledge of the meaning of the word and an ability to relate the particular attitude to it.

A Likert-type scale, on the other hand, depends on the direct assessment of the attitude. The items in this scale are all measuring the same attitude. Respondents rate their attitude towards these items on a five-position scale.

The construction of a Likert-type scale is easier than Osgood's semantic differential scale. Generalizability of the result is also greater. However, the reliability and validity of Likert-type attitude scale suffer from the language interpretation of the items and are affected by the cultural background of the respondent.

4.2.4 Pupil Opinion and Reaction

Pupil opinion and reaction is important for curriculum evaluation. Pupils have their own views of the curriculum which differ from those of the teachers. Pupils' opinions and reactions can be assessed by interviews and paper-and-pencil reports.

The difficulty with pupils expressing their opinion is they are mostly influenced by teachers' expectations from them. In some situations it is possible to obtain a reliable opinion from the student. This could be done by the use of closed-circuit television to record all the activities going on in the classroom. An interpretation of these activities could be used for curriculum assessment. This type of enquiry is more applicable for formative evaluation.

A technique called "classroom observation" (27)(28) has been developed for objective study of the students' opinion and reaction. This is a promising technique for formative evaluation of the classroom activities.

At the secondary school level, by a careful research design, one could obtain an overall view of students' opinion about different aspects of the curriculum innovation. At this age, students should be more or less independent from the teacher and can be interviewed for investigation about their opinion and reaction.

Group discussion, evaluation conference, in-service courses:

A group discussion with the teachers could be organized to evaluate their views on the curriculum innovation. This discussion could take place in school or in in-service courses. The advantage of group discussion is individuals moderate their views in response to others and provide a more generalized opinion about the subject. Also, teachers have the opportunity to exchange their experience and so overcome difficulties arising in individual cases.

In a conference a wide variety of people with different backgrounds could be anticipated. The discussion can be affected by a minority who form a pressure group. But with careful organization the outcome is invaluable for the curriculum evaluator.

The drawback of these assessment techniques is the organization, time, cost and other limiting factors which make their application to a minimum′rate for curriculum evaluation.

4.2.5 Visits and Observation

Visits to school and classroom provide invaluable information about the environment of teaching and learning. Much information can be obtained by direct observation that could never be detected by the use of paper-and-pencil techniques. The results of the visits to the school can be recorded by structured or un-structured schedules. The classrooms can be assessed for their suitability for certain teaching methods. Teaching methods could be assessed by the use of various objective techniques, i.e. Flanders schedule.

The facilities and laboratory equipment of the school can be assessed for deciding the strategy of the research in these environments. (29).

Visits to various departments involved in curriculum development, teachers' training and administration and interviews with decision makers are also useful for evaluating the causes and effects of curriculum development.

4.2.6 Other Techniques

Other techniques include teachers' diaries and the description of the history of curriculum developments. These techniques are useful for the study of the process of curriculum development.

4.3 Measurement and Testing

The primary effect of a curriculum innovation is on students' learning and behaviour. Several measurement instruments have been developed to evaluate this effect. The most popular of them is the "test".

A test is a series of questions to measure skills, knowledge, aptitude or intelligence capabilities of one or a group of individuals. The only kind of test discussed here is the achievement test.

There are some technical issues associated with the management of testing, which are discussed first:

1. Control group. The establishment of a control group is a subject of debate among curriculum evaluators. Ideally achievement of the experimental group is compared with achievement of a control group. The gain is interpreted

as the effectiveness of the curriculum innovation.

There are many problems when the above experimental design is applied:

A. The allocation of a class as a control group makes the students and the teacher aware of their artificial condition and alters their behaviour. (30).

B. The comparative study of the control and experimental group may suffer from contamination between groups and affect the results.

It is therefore recommended that the use of the control be restricted to certain conditions in which either the above conditions do not exist or several innovations in the same field exist. (31). In this case one group can be treated as an experimental group and the rest as control groups. The alternative design can be found in centralized systems of education where students of different schools (in this case vocational and academic schools) have different curricula and are housed in separate institutions.

2. Pre- and Post-testing. An alternative solution to the problem of establishing a control group is to test the same students at the beginning and at the end of instruction. Differences between the two measurements can be interpreted as the effectiveness of the curriculum innovation.

Stake (32) criticized the use of standardized tests in pre- and post-test design. He argued that the gain is unreliable, since there are always errors due to the learning that actually did not occur. He suggested that the use of a longer test or calculation of discrepancy between the actual and expected final performance should be used for improving the reliability. (33).

There are other problems associated with pre- and post-test design: the use of a pre-test makes students sensitive towards the course objectives and alters their behaviour. This effect does not always happen when a careful experimental design is achieved. (34).

3. Different kinds of achievement tests. In classical test theory model, the main objective of testing is to measure an individual's score in relation to scores obtained by his norm group. Tests are constructed to produce maximum discrimination amongst individuals. This kind of test is generally referred to as the Norm-referenced Test (N.R.T.).

In another approach to testing, individual's scores are interpreted independently against specified performance standard. (35). This kind of testing is generally known as Criterion-referenced Test (C.R.T.). The "performance standard" has been interpreted differently and has led to the development of various kinds of criterion-referenced tests.

For example, the Skinner's theory of learning was applied in C.R.T. and it was concluded that the specified performance standard refers to the establishment of well-defined domains in instruction. Each objective was treated as a domain and certain rules, item form in this case, were developed to create homogeneous items to measure the achievement of the objective. This kind of criterion-referenced test is known as "Domain-referenced Test. (36).

The popularity of the use of criterion-referenced test for curriculum evaluation originated from dissatisfaction with the use of standardized tests in evaluation research. The standardized test had the following characteristics. (37).

1. The test was designed to measure those skills that were stated by the objectives of the test. These objectives were usually different from those of specific curriculum in that the test was used to measure its effectiveness.
2. The standardized test was constructed to minimize the group differences and maximize individual differences. This quality of the test made it insensitive to evaluate differences between instructions.

The experience of curriculum developers in the 1960's in using standardized tests for comparative studies led them to the use of criterion-referenced tests.

The criterion-referenced test had several characteristics that made it suitable for curriculum evaluation. (38).

1. The test items are based on curriculum specific behaviour objectives.
2. The test items are specifically designed to measure performance on these objectives.
3. Scores are interpreted in terms of students' level of competence in respect to the curriculum objectives.

4.4 Summary

Most of the present ideas in curriculum evaluation are the result of the last twenty years of development in curricular studies. Several models have been created to evaluate the effects of different curricula. These models can be classified into two general categories: a) goal-attained models; and, b) illuminative models for evaluation.

In response to the critical issues on curriculum evaluation each model provides its own version. However, the following can be summarized from the above development:

1. The effects of curriculum innovation could be due to intrinsic or extrinsic criteria which can be classified as primary effect, i.e. student achievement, secondary effects, i.e. teachers' attitude or tertiary effects, i.e. other teachers' attitude.
2. The evaluation of the curriculum in the trial stage leads to a continuous or formative evaluation which provides feedback to the curriculum developers.
   However, when the curriculum is on the market, summative evaluation provides a summative judgement of the effects.
3. Both the goal-attainment model and the illuminative evaluation model has a built-in strategy for curriculum evaluation. While the strategy of the first one is restricted by the effect of the prespecified objective, the latter has more flexibility in its approaches in curriculum evaluation.
4. The evaluator could be a teacher, a member of a curriculum committee, or an outsider who is familiar with evaluation and research in education

and the area under study. Each of these would have different objectives for evaluation and provide different reports for their employer.

5. The use of an outsider for evaluation studies and deliberate negation of the prespecified objective leads the evaluation study to detect all the intended and unintended effects. This strategy provides better information about the effectiveness of the curriculum.

6. As the result of the application of various models with different strategies new techniques were created for assessment and measurement. The choice of these techniques, however, depends on the goals and roles of the evaluation and the strategies involved.

   The most significant development, however, is the development criterion-referenced test which maximizes the difference between groups which is of great interest in evaluation studies.

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He then points out that these stages should be considered in a matrix with the following sources: 1) intents; 2) observation; 3) standards; and, 4) judgement.

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CHAPTER FIVE

A MODEL FOR THE BIOLOGY CURRICULUM EVALUATION

In this chapter, evidence and data discussed in the previous chapters are used for the development of a model for evaluation of the ecology curriculum.

5.1 Definition of Terms

Most of the terms used in this chapter have already been defined in the Introduction of Chapter Four. Sometimes, in the course of the discussion, the term "effectiveness" was used for curriculum evaluation. This term was used in a wide sense to cover all the primary, secondary and tertiary effects, as well as interaction between these variables. It also included the unintended effects, i.e. hidden curriculum. However, as will be noticed, the scope of the study had to be limited to a few effects - a manageable number of variables that a single evaluator could handle.

The use of the word "evaluation" should not imply, however, that the present study is limited to evaluation of the curriculum. The model of curriculum evaluation discussed here is a research design for developing a more generalized model which would be applicable to similar cases.

5.2 Statement of the Problem

In 1974 a new biology curriculum was implemented at the first year of general secondary education. Several other versions of this curriculum were also developed for other branches of secondary education, e.g. in humanities, comprehensive and vocational hygiene.

In the first year of general secondary education (branch experimental science) ecology was taught in the first five months of the academic year. The rest of the year was allocated to the teaching of hygiene.

The present study is only concerned with the ecology curriculum in the first year of the academic education (branch experimental science). The problem is as follows:

1. To study the development of the ecology curriculum.
2. To evaluate the effects of the innovation.
3. To develop a model for evaluating a biology curriculum in a changing society.

5.3 The Background and Significance of the Study

A. General Characteristics of the System of Education

The country has a population of 34 millions; 45.5 percent of this population are under the age of fifteen. The rate of illiteracy is estimated to be 50 percent. There are 50,000 villages in which live 60 percent of the population. (1).

There are several indigenous languages and cultures. The effect of Islamic laws, culture, and its philosophy of man, society and knowledge is permanent. These values are in conflict with the invading western values.

The system of education was modelled on the French system of education. There was a highly centralized system of education which controlled the development and implementation of the curriculum and textbooks. It is also responsible for the allocation of manpower and resources in urban as well as rural areas.

The role of education was to create a unified and uniform nation. Local differences and indigenous languages and cultures were deliberately ignored.

The introduction of a new system of education, in 1966, was the result of a series of socio-economic reforms masterminded by the Monarch. Since then, many other reforms have been introduced to help to eradicate illiteracy. They aimed to provide an upmoded and egalitarian system of education, making schooling free for all levels. The overal result has been a quantitative expansion of the system of education - particularly at the secondary level. (2).

Secondary education was merely an urban institution. In the New System of Education, varieties of schools and specialized branches of studies were established. The greatest emphasis was made on technical and vocational education. The recent economic boom and rapid industrialization justified such a policy. As the result of the establishment of industries in various cities, the population of these areas increased and the numbers of students there grew in disproportionate ratio to other areas. The establishment of a university in each of these cities, together with the reluctance of teachers to work in small towns had the effect of increasing the population of specialist teachers in industrialized areas.

B. The Biology Curriculum

The New System of Education replaced the old one grade by grade. At each stage of this transitional procedure, the old system and the new shared the same manpower and facilities in the school.

The change in the secondary education - namely the establishment of one year general secondary education, followed by three years of specialized courses, had a dramatic effect on the new biology curriculum. It included several areas, i.e., ecology, genetics, human reproduction and evolution. As the result of the omission of the second year of the general secondary education, only ecology remained for the first year syllabus. It was decided to add hygiene to ecology and allocate equal time for each topic. The impact of this combination had dramatic effects on the students' and teachers' attitudes.

The new biology curriculum made no provision for any evaluation programme to study its effects. No effort was made to define its general goals as more specific behavioural objectives. The subject teacher became responsible for evaluation of the students' attainments.

Teachers were the output of a higher education system that had been alienated from the needs of society and industry for many years previous. The teachers' training was not in line with the requirements of the new system of education.

A massive programme of in-service training courses for the teachers was immediately established before and after implementation of the new secondary education.

C. The Significance of Study

The significance of study was to:

1. Provide a description of the process of the curriculum development.
2. Provide information and data for judgement

about the worth of the curriculum.

3. Provide information about the students' attainments and deficiencies in the instruction which may lead to improvement of the course.
4. Provide information required for understanding the factors effecting implementation and dissemination of a curriculum in a changing society.
5. To illuminate the characteristics of the intended and unintended effects.

The model could also be a great help to the biology teacher by providing instruments in Farsi to help them, in their own situation, to guide their students and investigate their curriculum developments.

5.4 Assumption and Hypothesis

From the above discussion, and that outlined in the first three chapters of this thesis, it can be assumed that:

1. The content of the textbook is taught in every secondary school throughout the country.
2. Examination is governed by the subject teacher.
3. The majority of the teachers have taken part in in-service courses and are familiar with the ecology curriculum.
4. All students have studied general science for the three years at the Guidance Cycle and are familiar with basic technical terms in biology.

Therefore it can be hypothesized that:

A. Students are achieving the curriculum objectives.

B. Teachers are successful in implementation of the ecology curriculum, and

C. The condition of a changing society is favourable for implementation of a curriculum innovation.

5.5 Limitation of Study

There are several factors which have restricted the scope of the present study, amongst them one can name the following:

1. Lack of basic information on: a) students' abilities; b) teachers; and, c) school situation.

These factors affect the strategy of the curriculum evaluation.

2. Crowded classrooms and lack of school facilities, i.e. the nonexistence of a hall for testing affects and restricts the management and procedure of testing.

3. Lack of research in education affects the development and selection of instruments and techniques for assessment.

4. Disproportionate range of distribution of the population of students, teachers and schools affects sampling design.

5. The presence of the researcher in England affects the role of the evaluation.

5.6 Research Design

In view of the above discussion, especially the limitation factors, the following model for curriculum evaluation is proposed. This model, also, based its principles on three kinds of information that are available in the previous chapters: 1) the development of the new system of education and the realities existing in the changing society (Chapters 1 and 2); 2) the development of the biology curriculum (Chapter 3); and, 3) the literature survey of the current trends in curriculum evaluation, assessment and measurement (Chapter 4).

5.6.1 The Model for Ecology Curriculum Evaluation

It was decided to give the model an overall role of summative evaluation.

The most significant limiting factor, for implementation of formative evaluation, was the fact that the writer was a full-time student at Bath University and could not possibly organize a formative evaluation from overseas. The other reason was that the existing information about students, teachers and institutions was not sufficient for formative evaluation.

Formative evaluation requires regular visits to schools and continuous study of the procedure by qualified teachers. These conditions are not obtainable in Iran.

The goals of evaluation are those mentioned in the statement of the problem. These goals automatically suggest the use of goal-attainment (or experimental evaluation) with illuminative evaluation to be the evaluation strategies (see discussion in 5.6.1.2 below) of the model.

The non-existence of research instruments in Farsi and the lack of information on various aspects of the curriculum development dictate the use of a pilot study prior to the experimental stage.

5.6.1.1 Intrinsic Evaluation and Curriculum Analysis

The first question in evaluation is the worth of the curriculum itself. Scriven, who has posed this question, suggested the use of intrinsic evaluation for the judgement of the worth and merit of the curriculum. (4). An alternative technique is curriculum analysis. (5). In practice, when the content of the curriculum is used for analysis the boundaries of their enquiries overlap. However, throughout this study the word intrinsic evaluation was used for specific situations where goal and curriculum analysis were discussed.

In the case of the biology curriculum, there is no detailed list of behavioural objectives. General goals of the experimental science curriculum (Appendix 1) are only guidelines for curriculum development, not specific objectives for the ecology curriculum. The two goals (6) proposed by the biology committee, were supposed to be applicable for all the biology curriculum (see Appendix 1, page 5).

The question was how far these general goals have been translated into the textbook.

Goal analysis provided a detailed list of all the intended objectives in the curriculum. The list covered behavioural objectives in three cognitive, affective and psychomotor domains (7)(8)(9). In the case of the ecology curriculum, the curriculum analysis could not be directly applied. A specially designed curriculum analysis was required to provide a summary of the content; the sequence and development of the concepts, disciplines and principles (10); and the list of all the technical terms (11)(12) involved. This analysis should provide enough background of the Farsi textbook for an English reader to follow the process of curriculum evaluation.

The next stage was the translation of content analysis into behavioural objectives.

Once the result of the two goal analyses, from the curriculum goals and the textbook, was available, it would not be difficult to compare them. (13). This comparison was also useful for understanding the extent curriculum objectives had been translated into the textbook.

The absence of a set of prespecified objectives provided a condition for "Goal-free-evaluation". (14). In the case of the ecology curriculum the result of the intrinsic evaluation, as well as of the extrinsic evaluation, was a goal-free evaluation. Goal-free evaluation not only covered the author's objectives but also detected the existence of unintended objectives, i.e. hidden curriculum. It is also this condition that justifies the application of illuminative evaluation.

Also, goal analysis and curriculum analysis can provide very useful information for the development of the kind of test known as criterion-referenced test.

5.6.1.2 Extrinsic Evaluation

The next stage in curriculum evaluation is the evaluation of the effect of the innovation on students, teacher and institution, after its implementation.

As mentioned a~~s~~t the beginning of this section, a summative evaluation role is adopted for both intrinsic and extrinsic evaluation studies.

The lack of basic information about different variables, and the changing nature of the system of education in the society, required the collection of a wide range of data from many sources. Illuminative evaluation strategy was an ideal strategy for description and illumination of the cause and effects involved in the curriculum development. Experimental strategy, on the other hand, concentrated on students' achievements, attitudes etc., for which special instruments and techniques could have been developed.

The pilot study and experimental stage benefitted from the illuminative and experimental strategies. The Diagram 5.1 shows the overall design of the ecology curriculum evaluation.

5.6.1.3 <u>Data Collection Procedures</u>

The pilot study was not restricted to the collection of data about various aspects of the curriculum. As a result of the intrinsic evaluation and the application of the curriculum analysis, certain data required for test development was already provided. In the pilot study, it was possible to pre-test the achievement test items in order to revise them for further use. It was also possible to monitor the procedure and management of testing to formulate a strategy for the future.

However, the study of the students' and teachers' attitudes by the use of an attitude scale was rejected in the present study. The most important reason was the lack of any reliable attitude scale in Farsi, and the complicated process involved in the development of such instruments in any language. (1~~6~~5).

Diagram 5.1: The overal design of the ecology curriculum evaluation model.

ECOLOGY CURRICULUM EVALUATION

INTRINSIC EVALUATION

Curriculum analysis
Goal analysis

EXTRINSIC EVALUATION

Evidence from the Student:

1-Achievement.
2-Attitude.
3-Interview.

Evidence from the Society and Institutions:

1-Analysis of the changes.
2-Study of the school situations.

Evidence from the Teachers:

1-Questionnaire.
2-Interviews.
3-Observations.

It was decided to investigate students' and teachers' attitudes by interviews and from their writings about the curriculum.

Data about the Iranian biology teachers was scarce. The only information available was some statistics about their numbers and the types of certificates they possessed. It was decided to develop a questionnaire that based its item development on four kinds of information:

1. Information obtained from the study of the curriculum materials.
2. Study of the goals and objectives of the curriculum.
3. Interviews in the pilot study.
4. Areas where data was not available.

Teachers' questionnaires had to be prepared after the termination of the pilot study and analysed before the implementation of the experimental stage. This procedure could provide an opportunity to organize a random interview with the teachers which could clarify their views and validate the questionnaire.

A student questionnaire was prepared at this stage to check some of the teachers' claims and provide a concurrent validity for the teachers' questionnaire.

Other techniques and instruments used were unstructured and structured observations, visits to schools and classrooms.

Sometimes an indirect method of data collection was encouraged by interviewing administrators and headmasters. This method was similar to the detective's study of the crime (1~~7~~6); a non-experimental design in which the cause and effect of the phenomenon under study was inferred from indirect interpretation of the evidence.

The achievement test, for the evaluation of the effectiveness of the ecology curriculum, was a criterion-referenced test. This was suitable since its design was directed to maximize group difference and measure individuals' achievement of the objectives. (1~~8~~7).

The fact that vocational schools did not have any biology in their first year curriculum, provided an ideal control group with minimum degree of contamination from other schools.

The experimental design for the achievement testing was "post-test only control group design". (1~~9~~8). This design was applied by random sampling of the population of both control and experimental groups. This design was preferred to pre- and post-design since pre-testing the student was not possible.

The control group for this design had none of the conditions that had led Cronbach to reject the application of double-blinded control design.

In the case of ecology, the whole country studies the same curriculum, which is restricted to the study of a single textbook. The control group had no biology in their curricula and they were housed in separate schools.

At the time of this study no techniques for assessment were available in the Iranian system of education. Teachers' tests were not prepared or analysed by any standard means. In these tests several questions were given to students. The total mark was equivalent to the number of questions correctly answered. Also, the minimum pass mark was 12 over 20. The last two conditions have similarities with the way data from mastery learning is interpreted and can be easily used for the establishment of a CRT technology testing.

5.8 Summary

The model of the ecology curriculum development was based on the evidence from three sources: 1) analysis of changing society and system of education; 2) biology curriculum development; and, 3) a literature survey.

There were certain restrictions which affected evaluation goals and roles of the model and the choice of strategies.

The model was basically a summative model. It was operated in two stages: 1) pilot; and, 2) experimental stage. In both stages, a combined experimental and illuminative evaluation was used.

The first theme of the model was intrinsic evaluation of the curriculum materials. This evaluation fulfilled two objectives: 1) it provided data for the judgement of the worth of the curriculum itself; and 2) it facilitated the development of instruments required in the extrinsic evaluation.

The extrinsic evaluation aimed at evaluating all intended and unintended effects of the innovation. Interaction between variables involved in curriculum development was also considered. In practice, the choice of the effects was limited to the study of evidence from students, teachers and the society and its institutions.

This limitation also restricted the choice of assessment techniques. On the whole the achievement test, questionnaire and observational schedules were the structured instruments. A wide range of techniques and methods were used for non-experimental enquiries.

The development of the model for curriculum evaluation was part of the research on how to facilitate the development of a more generalizeable model for biology curriculum evaluation in a changing society.

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CHAPTER SIX

THE PILOT STUDY

Curriculum innovation is shaped in the society and educational system in which it has been developed. At any stage of its progressive changes, innovation slows down and reaches a relatively steady state or a curriculum climax. (1). Summative evaluation is the evaluation of one of these curriculum climaxes at a continuum of time.

The pilot study was such an evaluation programme which was conducted on a representative sample of the total population. Due to the continuous changes in the Iranian system of education, it was necessary to adopt an illuminative evaluation strategy to obtain varieties of information on varieties of curriculum effects. The information could either be used for projecting a hypothesis for an in-depth study of the problem areas or be applied to the revision and development of instruments during the pilot study. The role of the experimental strategy was limited to the development of the achievement test and the application of a structured observational scheme.

This chapter is divided into two sections. The first section deals with intrinsic evaluation. The second section is about extrinsic evaluation. References for both sections can be found at the end of the second section.

6.1 Intrinsic Evaluation

The evaluation of the curriculum intrinsic criteria is a process of judgement of the curriculum materials. The instruments used for studying general or specific aspects of the curriculum materials, curriculum analysis and goal analysis are the most commonly used instruments in curriculum evaluation.

There are controversies on the scope of enquiry that a curriculum analysis scheme could pursue. Each of the existing curriculum analysis schemes has certain areas in the curriculum material and omitted the others. It has even been argued that curriculum analysis schemes could have a wider application than intrinsic evaluation programmes. (2).

In the present study the term curriculum analysis has been used in connection with the Biology Curriculum Analysis Scheme (B.C.A.S.) (Appendix 12). B.C.A.S. was developed to analyze the content of the biology textbook and provide specific data about the curriculum materials. In this context, the role of the curriculum analysis scheme was very limited.

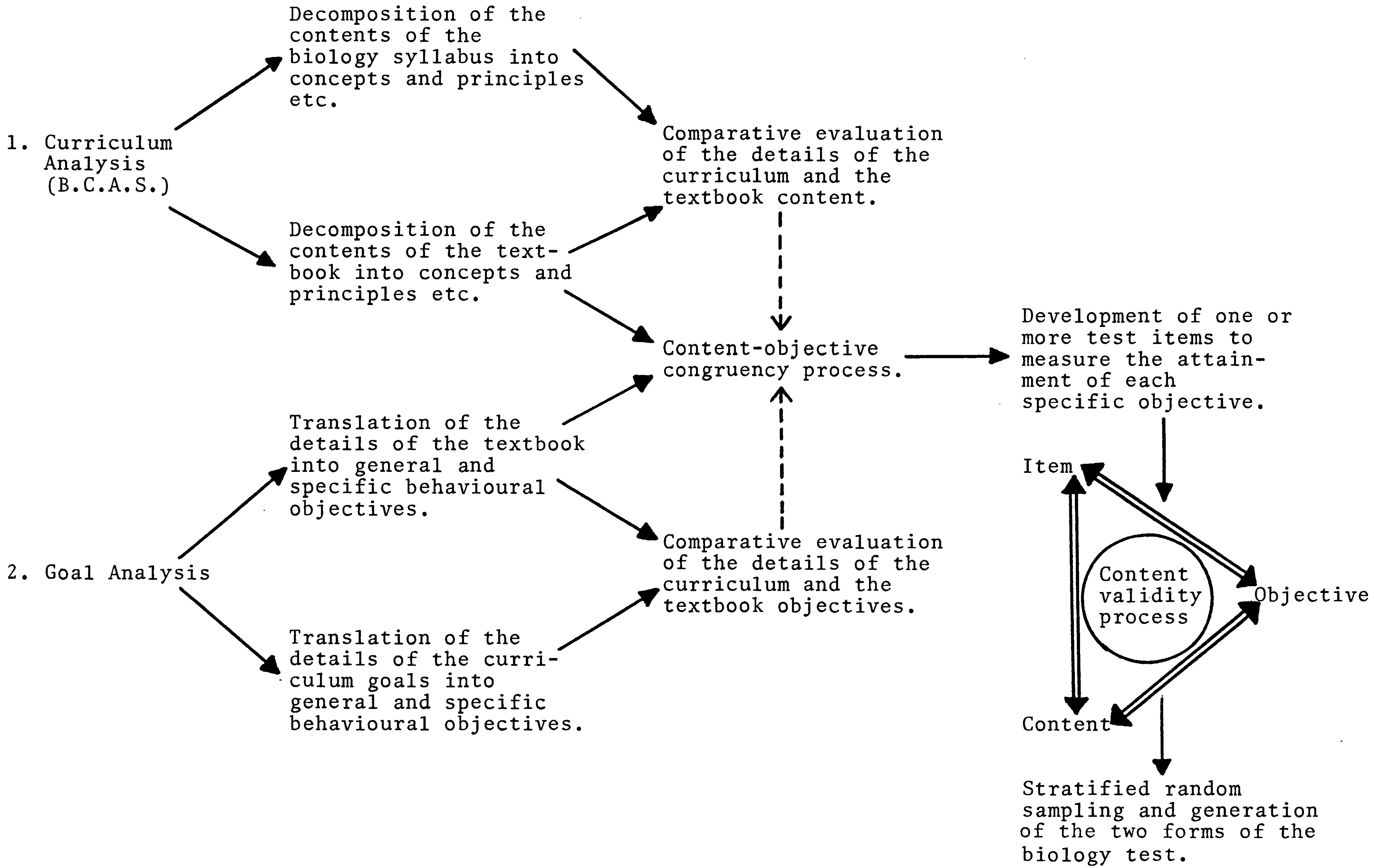
The goal analysis, on the other hand, was the process of translating curriculum goals and the contents of the biology textbook into general and specific objectives.

Intrinsic evaluation involved the comparison of data obtained from the above instruments in order to judge the merits of the curriculum materials (Figure 6.1).

6.1.1 Biology Curriculum Analysis

The curriculum analysis schemes discussed in the previous chapter, were curriculum specific. (3). They were aimed to provide specific information about particular aspects of the curriculum materials. None of these schemes, however, could be applied to provide information needed for

Figure 6.1: The process of Intrinsic Evaluation and the Development of the Biology Test.



the present study; but they could be used as a source of ideas to develop a new scheme.

The objectives of the biology curriculum analysis scheme were:

1. To provide general information about the biology curriculum materials, and also specific data about the students' textbook, for an English reader of this thesis.
2. To provide comprehensive information about technical terms, sequence and development of concepts and principles in the textbook.
3. To facilitate the development of an achievement test and other instruments required for the present study.

To satisfy the above objectives the B.C.A.S. was divided into two sections. The first section described the general environment of the curriculum. In the second section specific data about the textbook was given (Appendix 12).

In the process of the analysis of the content of the biology textbook, the content of each chapter was decomposed into technical terms and concepts and principles. The sequence of the development of concepts and principles were identified and various activities in each chapter were described. Table 6.1 provides a summary of this.
(More details can be found in Appendix 3.)

Table 6.1: The general comparison between chapters in the different biology textbook editions.

1974 and 1975 Editions	1976 Edition
Introduction: The web of life	Integrated with Chapter 4
Chapter 1: Autotrophism	The web of life
Chapter 2: Heterotrophism	Population
Chapter 3: Structure of an Ecosystem	Interaction
	Structure of an Ecosystem
Chapter 4: Functions of an Ecosystem	Producers and Consumers
	Aquatic Ecosystem
Chapter 5: Population	Terrestrial Ecosystem
Chapter 6: Interaction	Man and the changes in the Ecosystem
Chapter 7: Aquatic Ecosystem	
Chapter 8: Terrestrial Ecosystem	

In the following paragraphs some aspects of this analysis is discussed.

In the biology curriculum developed in 1973, ecology was treated as an integral part of the biological principles. In the revision of this curriculum, ecology gained an independent status and was allocated for the first year of the general secondary education level.

The sequence of the titles in the 1974 and 1975 textbooks showed that it was more or less in accordance with that of the curriculum content.

In 1976 this sequence changed. The main reason for this change was due to the results obtained in the pilot study. Students at the first year of the secondary education could not understand chemical formulae, and found the chapter on "Autotrophism" extremely difficult to grasp.

Early in 1973, when the Biology Committee was studying the background of the general secondary education, they realized that students' knowledge of chemistry was insufficient. The committee recommended the formation of a co-ordinating committee whose function was to co-ordinate the contribution of each of the experimental sciences. They were to report to the Biology Committee on the progress and detail of the curriculum development of other related subjects. This committee never carried out its duties.

Finally, the biology curriculum was prepared. The cellular and molecular part of the syllabus was transferred to the second year. It was hoped that by then the students would have gained enough knowledge of chemistry.

In 1976, the textbooks for the Guidance Cycle, and the first year chemistry of the secondary education, were still unchanged. (4). The only way to improve the biology textbook was to change the sequence of its chapters. Since most of the chemical formulae were in the first two chapters, they were transferred to the middle of the biology textbook.

The 1974 and 1975 textbooks saw the introduction of the "web of life". The aim of this section was to give a general picture of the ecology that was to be introduced, in detail, during the academic year.

In the 1976 edition, this introduction was merged with chapter 4 (on the function of Ecosystem). It was then called chapter 1 and the old introduction was eliminated (Table 6.1).

Table 6.2: Summary of the analysis of the content of the biology textbook (the first 100 pages on ecology) (1).

Chapter title	Percent of space occupied	No. of Experiments
Text	40.60	7
Illustrations	30.43	-
Summary	2.05	-
Questions	6.10	-
Activities	2.60	8
References	3.05	-
Empty space	15.17	-
Total	100.00	15

(1) Abridged from Table 1, Appendix 3, page 7.

Chapters one and two were merged to form a new chapter four. Other details of the 1976 edition can be found in Appendix 4 and Table 6.1 above.

A study of these details showed that this change did not affect the integrity and general understanding of the concepts and principles of the ecology as advised in the contents of the biology curriculum. It provided a new sequence in the contents which facilitated students' learning.

However, goal analysis should project more light on the effect of this alternation on the students' learning of the main concepts and principles.

6.1.2 Goal Analysis

Goal analysis was a process of translating details of the textbook and the curriculum goals into the general and specific behavioural objectives.

The following characteristics were previously described for the biology curriculum materials:

1. The biology curriculum was part of the experimental curriculum for the first year of the general secondary education. The general goals defined for experimental curricula, were guidelines for the development of biology, chemistry, geology and physics curricula. (5). These goals were not defined in specific terms.
2. The two specific goals for the biology curriculum were directly associated with the ecology curriculum.
3. The material of the ecology curriculum consisted of a single textbook.
4. No teacher's guide was ever produced.
5. The author's rationales for the textbook and the curriculum goals were guidelines for the development of the curriculum materials and has no comparative value for evaluating the curriculum goals with those of the textbook.

The first stage of the goal analysis was to find an instrument that could specify curriculum and textbook behavioural outcomes. The Taxonomies of Educational Objectives in the cognitive, affective and psychomotor domains provided this instrument. (6)(7)(8).

The usefulness of these taxonomies were (see also Appendix 2):

1. They all had a hierarchy of objectives in their taxonomies.
2. They all defined objectives in a behavioural and operational manner.
3. They all used standardized terminology which eliminated distortion in interpretation of intents and led to the development of a yardstick for comparison between two independent sets of curriculum objectives.

Using the three taxonomies of educational objectives, details of the content of the textbook were translated into general and specific behavioural objectives (Appendix 2).

In this process, details of the content of the textbook were first translated into general behavioural objectives. Then by reading the details of the chapter, each general objective was broken down into specific objectives.

It was very soon noticed that due to the limitation of the textbook in elaborating certain concepts and principles, many of the general and specific objectives referred to a single definition of a technical term: a situation that is characteristic of the foundation courses.

The same three taxonomies were applied in translating curriculum general goals into general and specific objectives. In this process evidence from the content of the curriculum, and personal notes made during the curriculum development, proved to be helpful in interpretation of the goals (see Appendix 2 for the details).

The preliminary evaluation of the two sets of the behavioural objectives showed that:

1. The scope of the curriculum objectives was very comprehensive and emphasized objectives that were not included in the textbook, e.g. scientific attitude.
2. The details of the content of the textbook behavioural objectives were a modest representative of the curriculum goals and objectives. (Table 6.3) The cognitive domain mostly included Knowledge and Comprehension. In affective domain: receiving; valuing and organization; and the Psychomotor Domain was concerned with developing skill in using equipment with safety and accuracy.
3. The role of the experiments in the content of the textbook was to fulfil the higher objectives that could not be achieved by rote memorization or understanding the text.

The examination of the developmental sequence of the chapters (Figure 6.2) shows that there was an inbuilt logic in the chapters' order and their presentation.

In chapters one and two of the textbook, there were several experiments to help mastery of the basic technical terms that were critical in understanding future materials. A deductive teaching method, supplemented by the discovery method, using experiments, was introduced to provide an efficient learning milieu for mastering these concepts.

Table 6.3: A summary of the goal analysis of the extent of the biology textbook for the first year of the secondary education in Iran.

Outcome / Content	Cognitive						Affective					Psychomotor	
	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Receiving	Responding	Valuing	Organization	Characterization	Developing skills in using equipment	Performance of techniques with safety
The web of life	X						X	X	X				
Autrotrophism	X	X	X	X	X		X	X	X	X	X	X	X
Heterotrophism	X	X					X	X	X			X	X
Ecosystem: Structure	X	X					X	X	X	X	X	X	X
Ecosystem: Function	X	X	X				X	X	X				
Population	X	X					X	X	X	X		X	X
Interaction	X	X					X	X	X				
Ecosystems: Aquatics	X	X					X	X	X				
Ecosystems: Terrestrials	X	X					X	X	X				

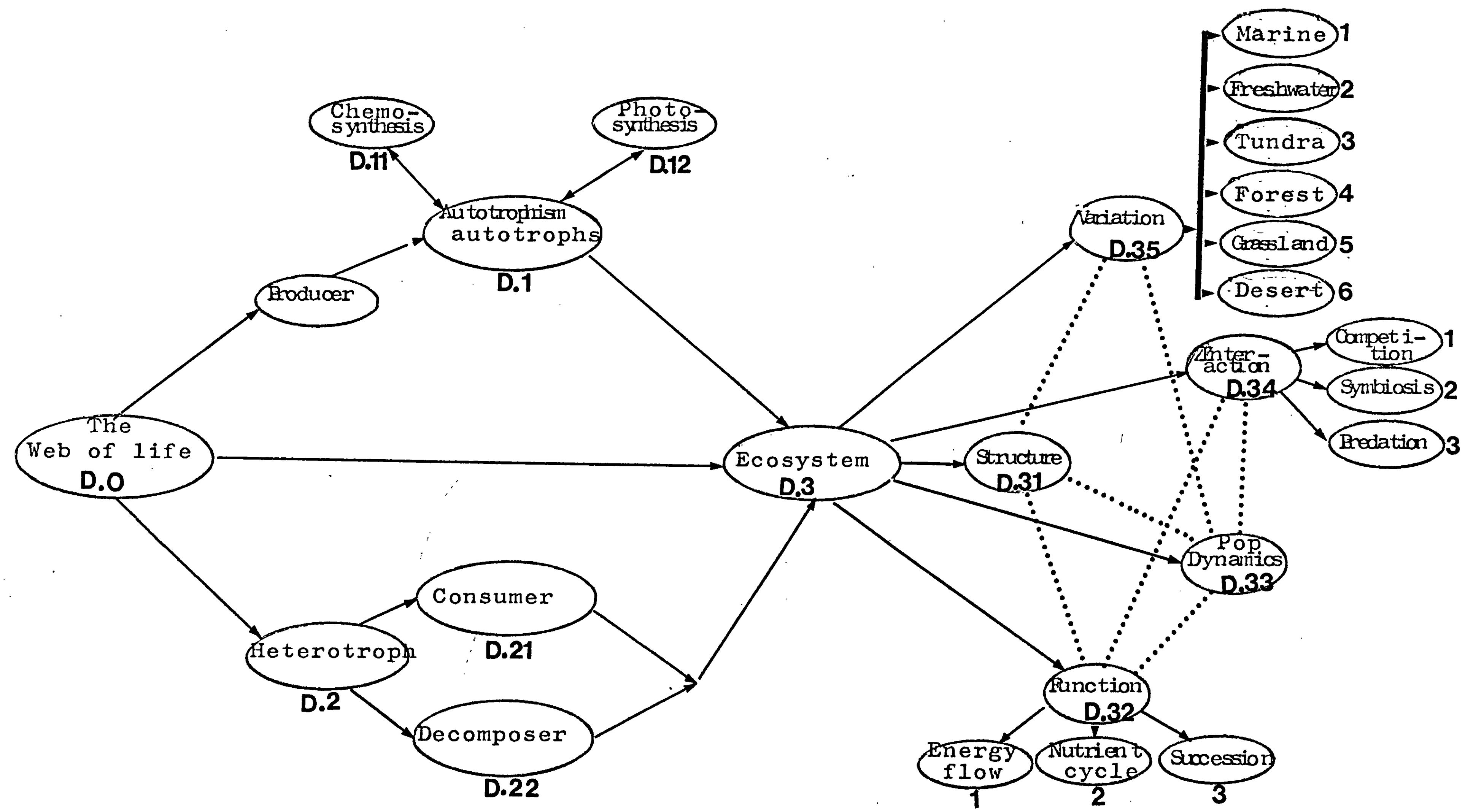


Figure 6-2 - The development of the main domains in the text-book. Numbers specify each domain and indicate its sequential appearance in the text. The solid lines indicate strong relationship between domains and dotted lines the loose relationship between some elements of one domain with another.

For example, in chapter one the word photosynthesis was introduced. It was then argued that green plants could make their food through photosynthesis. Van Helmonts' experiment in 1648 was the first attempt to explain this phenomenon. Van Helmonts' experiment was then introduced and it was concluded that water and small amounts of minerals could not be the only source of matter for the growth of the tree. There was a need of other matter. The bicarbonate indicator experiment showed that green plants absorb CO_2. This argument follows the step-by-step conceptual development discussed here:

1. Green plants required other sources of matter than water and minerals.
2. Green plants absorb small amounts of minerals.
3. Green plants absorb CO_2 in the presence of light.
4. Green plants release O_2 in the presence of light.
5. Green plants' absorbtion of CO_2 and their release of O_2 in the presence of light is a different phenomena from respiration.
6. Green plants use CO_2 for starch formation.
7. Starch is an organic material; a food.
8. Green plants make food from inorganic materials.
9. Green plants are therefore called "producers".

The concept of a producer is the ultimate objective of chapter one. The role of the experiments is to provide a deep understanding of this concept. This will facilitate the understanding of other concepts discussed in future chapters.

In these experiments students were encouraged to perform various activities. In the case of Van Helmonts' experiment, the activity involved was "to understand and interpret the data and apply them in a new situation". The other experiments provided first-hand and second-hand data about various concepts and principles. They fulfilled "scientific attitude" defined as the goal of the biology curriculum.

However, the above statements were only true for the first two chapters and chapter five (Population). The other chapters were descriptive and their only activities, which could be considered to be in the same line as the curriculum goals, were activities outside the classroom.

Activities outside the classroom were simple projects for students. These activities were based on individualized learning activity. The apparatus was simple and should have been available in every house. The most important objective of these experiments was to make the student interested in biology - an affective objective. Their activities involved various investigations and the use of varieties of techniques and skills (psychomotor objectives).

The change of the sequence of the chapters in the 1976 edition disrupted the above sequence in the content of the textbook. By the time students had reached chapter 4 (the new version of chapters one and two), they had either learnt or had been confused about the basic concept of the ecology curriculum. The results from extrinsic evaluation should provide more evidences for the acceptance or rejection of this hypothesis.

6.1.3 Summary

Most of the comparative data obtained from curriculum analysis and goal analysis discussed above have applications in extrinsic evaluation:

1. The change of the sequence of the chapters, particularly chapters one and two, in the 1976 edition, was to help students to be able to obtain enough chemistry knowledge to understand the chemical formulae. This change led to other consequences:
   (a) It disrupted the original in-built sequence of the domain development; and, the step-by-step concept learning, especially for the basic concepts, i.e. producer.
   (b) It postponed the study of chapters one and two, since they were transferred to the middle of the book, until ~~when~~ students could learn the basic concepts by other methods than discovery methods. This might affect the role of the experimental activities in chapters one and two and negate their effects on students' learning of other concepts which require a prior and deep understanding of the basic concepts.
2. The comparison between the curriculum and the textbook objectives showed that the higher objectives, i.e. evaluation, have not been translated in the content of the text but they could be fulfilled if self-assessment exercises, activities

outside the classrooms, experimental activities and the study of the references could be pursued by the students.

3. The new sequence of the chapters and the fact that many of the basic concepts had to be learnt before the application of discovery methods, might suggest that the experimental activities could be omitted. This might also lead to the omission of other activities which were all included for the attainment of the higher objectives. The consequence of this strategy in teaching and learning is the creation of an intrinsic hidden curriculum.

6.2 Extrinsic Evaluation

6.2.1 Evidence from the Society

Evidence from the society suggested that recent economic development and growth has provided an enormous amount of facilities and resources for the development of the country. Therefore, it was not ridiculous for the Shah to express his hope that "The country will achieve in a generation what took Japan a century to do; namely to become one of the world's most powerful industrialized nations." (9).

The allocation of most of the manpower and economic resources for the development of industry, army and technical and vocational education justified his ideology.

During 1972 to 1976 the allocation of most of the manpower and resources towards the campaign against illiteracy, severely affected the development of the new secondary education. The situation was more complicated when the system of secondary education was revised in 1975, and the educational policy became a centre of political attention. It followed that the political decision makers became more influencial and decisive in educational policies. As the result, several effects were monitored in 1975:

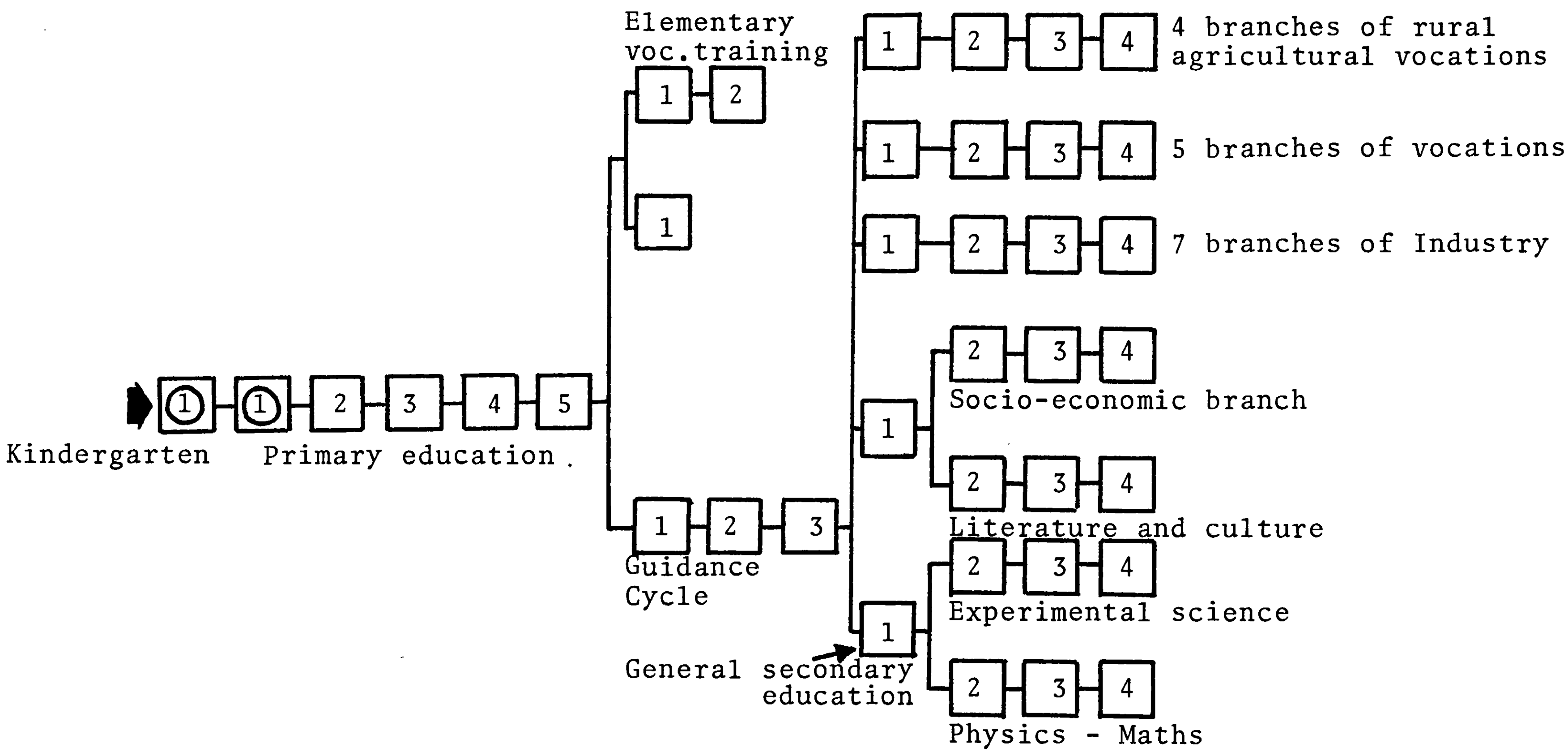
1. The experimental stage of introduction of the comprehensive education largely failed due to its hasty introductions and lack of adequate preparations.
2. The Guidance Cycle system and curriculum, faced much criticism from experts inside and outside the Ministry of Education. In 1975, it became a subject of national debate.
3. Different educational elites at the Ministry of Education showed various degrees of disagreement on how to implement and manage the new system of education. In practice, there was little or no co-ordination of activities between various departments at the Ministry of Education.

These factors affected management and implementation of the curriculum innovations.

In February 1973 the universal free education was introduced and in August 1974 the seventh Ramsar charter of educational evaluation recommended additional revisions in the new system of education. (10).

Following this charter, the secondary education underwent various changes (see Figure 6.3).

Figure 6.3: The system of education in Iran 1975-1977.



1. The first two years of the general secondary education were reduced to a one year course of general secondary education.
2. Comprehensive education became a future aim when the present system could be better prepared for such a transition. (11).
3. The vocational secondary education was expanded and divided into three branches: (a) industry; (b) vocational; and, (c) agricultural professions. (12).
4. The specialized branches at the secondary education level were divided into two branches in the first year: (a) humanities; and, (b) experimental and mathematical sciences.

   The last three years of the specialized secondary education also sub-divided into four branches: (a) mathematics and physics; (b) experimental sciences; (c) culture and literature; and, (d) economic sociology. (13).

In 1975, following the change in the system of education, a national aim for curriculum development for the whole new system of education was projected. (14).

According to this projection, there were four kinds of inquiries that should have been included in the new system of education:

1. Environmental studies.
2. Technological studies.
3. Mathematics.
4. Language and National culture.

Therefore, at the secondary education, students in any of the existing branches, should choose 60% of their subjects from specialized courses and the other 40% from general subjects. It was also recommended that at the last three years 80% of the subjects should be selected from the specialized courses.

Following this change in the system of education, the Minister of Education and all the deputy ministers and general directors were replaced by another group of bureaucrats. They came mostly from other sectors of the governmental institutions rather than the Ministry of Education. This abrupt change in all aspects of the system and the political pressure for the revision and improvement of the system of education had several unfortunate effects:

In May 1975 the deputy Minister in charge of the Department of Curriculum Planning and Research and Teachers' Training Department, chaired a joint committee of experts to discuss the current issues of the curriculum development. He asked the committee why in the last year the curriculum development became dormant. From the discussion that followed, several reasons were suggested:

1. Curriculum development had never been based on research and development.
2. Decisions on curriculum development were not made in a rational and democratic manner. Instant irrational decisions made by general directors ruined several months of efforts by the experts. This manner of decision making discouraged curriculum experts to continue their systematic activities.

3. The present curricula were adopted from the common topics found in the curricula of the developed countries to exhibit an up-to-date structure. This strategy could not be justified nor could the curricula be implemented successfully in a society which bore no similarity, in any respects, to those of the developed countries.

4. The abrupt change of the top decision makers changed the whole curriculum and even the system of education without asking what was done in the past and where the old system and its curriculum was faulty and wrong.

In the course of the pilot study it was noticed that experts at the Offices of the Ministry of Education were indifferent and alienated towards any innovations. This attitude was very dangerous in the delicate stage of curriculum development when their active co-operation and achievement were required. The reasons partly describe the change of attitude of these experts. Other reasons should be sought in the nature of the political system and the way it was operating.

6.2.2 Evidence from the Schools

In 1974, when the first year of the general secondary education was introduced, the old system of education was still operating. Therefore, it was thought by the administrators, that the first year of the general secondary education could be accommodated in the old secondary schools where teachers and facilities were provided for both.

The impact of this strategy was obvious. A headmaster treated the new curriculum in terms of additional classes added to the school organization. Therefore, with the lack of qualified teachers and additional funds, he had to allocate the same type of classrooms and biology teachers that he had for the old system of education to the students of the new biology curriculum.

In 1975, two years after the implementation of the biology curriculum, the situation was as follows:

1. The Head had no in-service training for the new system of education and was struggling to obtain vital data about examination regulations, books and other requirements from the bureaucracy which had imposed the new system.
2. He had no extra funds for the new curriculum, nor any guidance how to treat them. He had to use his initiative to satisfy all the people involved.
3. In most cases biology was described as another theoretical subject. Pressure was put on the biology teacher to finish the textbook according to the Ministry timetable. There was no understanding for the newness of this curriculum - nor did anybody want to treat it differently.

6.2.2.1 Pilot Study of the School Situation

In the course of the pilot study twenty randomly selected schools were visited in Tehran and Yazd. In seven of these schools various aspects of the ecology teaching and learning situations were studied intensively. Most of the school buildings were not suitable for housing secondary school students; classes were overcrowded and the only visual aid was the blackboard on the front walls. The yards were usually covered with asphalt and too small for active recreation.

In some schools in Yazd, some ornamental vegetation and trees were decorating the empty yard. None of these schools had any facilities for ecology fieldwork.

In terms of the laboratory facilities, few schools in the country were reported to have laboratory facilities of their own. (15). The schools that had laboratories were mostly private schools or old public schools which had inherited their facilities from missionary schools and foreign colleges.

There were three types of arrangements for the use of laboratory facilities:

1. Teachers had some apparatus of their own and were using them in demonstrations.
2. There was a central laboratory that several neighbouring schools could use by following a yearly timetable.
3. There were a few pieces of apparatus kept in a cupboard in the staff room for science teachers.

6.2.2.2 Classroom Observation Schedule

A classroom observation schedule (Appendix 9) was used to investigate the environment of the teaching and learning in the classroom. (16). This schedule was specifically chosen to investigate the practicality of the use of the discovery method, as emphasized by the biology curriculum methodology.

The results revealed that no facilities were provided to allow the application of the discovery method (Appendix 9). However, in Yazd, and two large schools visited in Tehran, the classroom environment could have been used for the application of this instructional method if the teacher had desired to do so.

Interviews with headmasters revealed that in the comprehensive schools they were more aware of the need of materials and equipment. They were given special funds to purchase technical equipment but the increasing number of students, lack of space, the tedious and time-consuming bureaucratic procedure for purchasing apparatus, had prevented it. In addition there was no room to display and use them. When the room was available there was nobody to use the equipment. In a few private and public schools these problems were solved partly due to the use of these laboratories as a supplement to the central laboratory.

6.2.3 Evidence from the Students

Students were mostly at the age of 14 or 15. They were from the top and medium ability groups of the Guidance Cycle. In a few of the schools they had divided their students into top, low and medium groups by using their Guidance Cycle total average marks. In most schools mixed ability was a common practice. Some private schools had introduced an entrance examination to select the best students from their neighbouring Guidance Cycle institutions; this latter situation only occurred in a few private schools in Tehran.

6.2.3.1 Students' Attitudes and Difficulties

An open-ended questionnaire of six questions was administered to students of seven randomly selected schools. The questions were written on the blackboard and students were asked to answer them using paper and pencil and oral responses. The questions were as follows:

1. What is your attitude towards ~~the~~ Ecology? Do you think Ecology could be of any use in your daily life?
2. What sort of books, films or articles have you read about Ecology? Please write their names and their details.
3. What sort of experiments have you done about Ecology? Please write their names and their description.
4. How did you treat the questions at the end of each chapter?
5. In which part of the book did you have difficulties?
6. What part of the textbook did you find interesting?

In several cases following the questionnaire, a group of students were selected and an interview was conducted to investigate students' attitudes, and the possibility of constructing an attitude scale.

The results from these enquiries revealed that:

1. Students' views of the science and scientists were the reflections of the society they live in

rather than the effect of the school curriculum, e.g. they mostly believed that scientific investigation only takes place in laboratories and by scientists.

2. Students' attitudes towards ecology, as predicted in the description of the research design, was affected by the hygiene which was more relevant to their age range. Students tended to compare ecology with hygiene and concluded which one was better or worse.
3. Unless a specific question about a specific part of the curriculum was used, they could not provide a universal view about a topic. The answer to the use of ecology was the reflection of their learning from the text or instruction. They would simply quote from each of these sources without using their own initiative.
4. Most of the students mentioned that they had not read any books or articles. But a few mentioned several names from the book references. In most cases they had seen the programme called "Survival" in Tehran, but few in Yazd mentioned any film that they had seen.
5. There were various responses on the treatment of the chapter questions.. They were either used as homework or class activities, but the role of the teacher in relation to these questions was not clear from their responses.

6. Most of the students indicated that they had difficulties in understanding chapter one on Autotrophism. The reason they gave was their lack of knowledge of chemistry. Some suggested that these chapters could be transferred to the middle of the book, so that their chemistry study in the first year could equip them with enough knowledge to understand the simple chemical formulae.
7. In most cases the chapters on Autotrophism and Ecosystems were least accepted. The chapter about the function of ecosystem, the web of life, rated high in the students' liking.

The above generalizations obtained from the short questionnaire led to the conclusion that students' response on factual knowledge was accurate. Where a general question, or something that required initiation of skills beyond school performances, was desired, the answer was unreliable, distorted or led to confusion of the point.

6.2.3.2 Students' Achievement Test

The achievement test prepared for the pilot study was based on the results obtained from content analysis. The objective of assessing students' achievement was to see what students can do and what they cannot do. This objective could also reflect the varieties of teaching methods since students' learning correlates with teachers' instruction and treatment of the curriculum materials.

A criterion-referenced test is the instrument that could fulfil the above objective since it has the following characteristics:

1. It is based on clearly defined educational tasks or objectives.
2. The test items are specially designed to measure performance of these objectives.
3. Scores can be interpreted in terms of attainment of a pre-set of criterion or level of competence with respect to the educational objectives.

The following steps were followed for item generation:

1. Details of the textbook goal analysis was treated as item universe. (17). Specific objectives were used as domains for item generation.
2. A stratified random sampling technique was used to select specific objectives from the general objectives and the item universe. In this procedure general and specific objectives were treated as strata for item selection.
3. Since it was predicted that conditions of testing would not facilitate ideal testing situations, where students could be located in a hall, two sets of tests were developed on the two sets of stratified randomly selected objectives. (Form A and Form B.)
4. Except for a few questions, on Van Helmonts' experiments, all of the pilot study questions were open-ended and short-answered items. They were similar to those questions students were used to meeting in their school examinations. Also, the use of short-answered questions facilitated the selection of plausible distractors for the

development of multiple choice questions.

5. There were 199 specific objectives and 70 general objectives in the detail of the goal analysis. All of these objectives had content-objective congruency since they were developed on the basis of the details of the curriculum analysis of the content of the biology textbook (see Figure 6.1).

Depending on the comprehensiveness of the specific objective, one or more test items were developed to measure the attainment of the behaviour involved (see Appendix 13). The next stage was to check content and behavioural output of the test item against the specific objective and its congruent content. This procedure was part of the content validity process, a prime condition for the development of criterion-referenced tests.

As the result of the application of the content validity process, defected items were rejected and only one test item was kept for the measurement of the attainment of each specific objective. These items were re-checked for their accuracy of measuring the content and the objective through the repetition of the item-content-objective process.

The two test forms developed from the above procedure (see Appendix 5) were tested on a group of 350 students in seven randomly selected schools, in an industrialized and agricultural city (Table 6.4).

As the result of interview with the students, it was discovered that students in the comprehensive school had only studied part of the ecology curriculum. This class was omitted from the final analysis of the test.

Table 6.4: Details of the samples used in the pilot study.

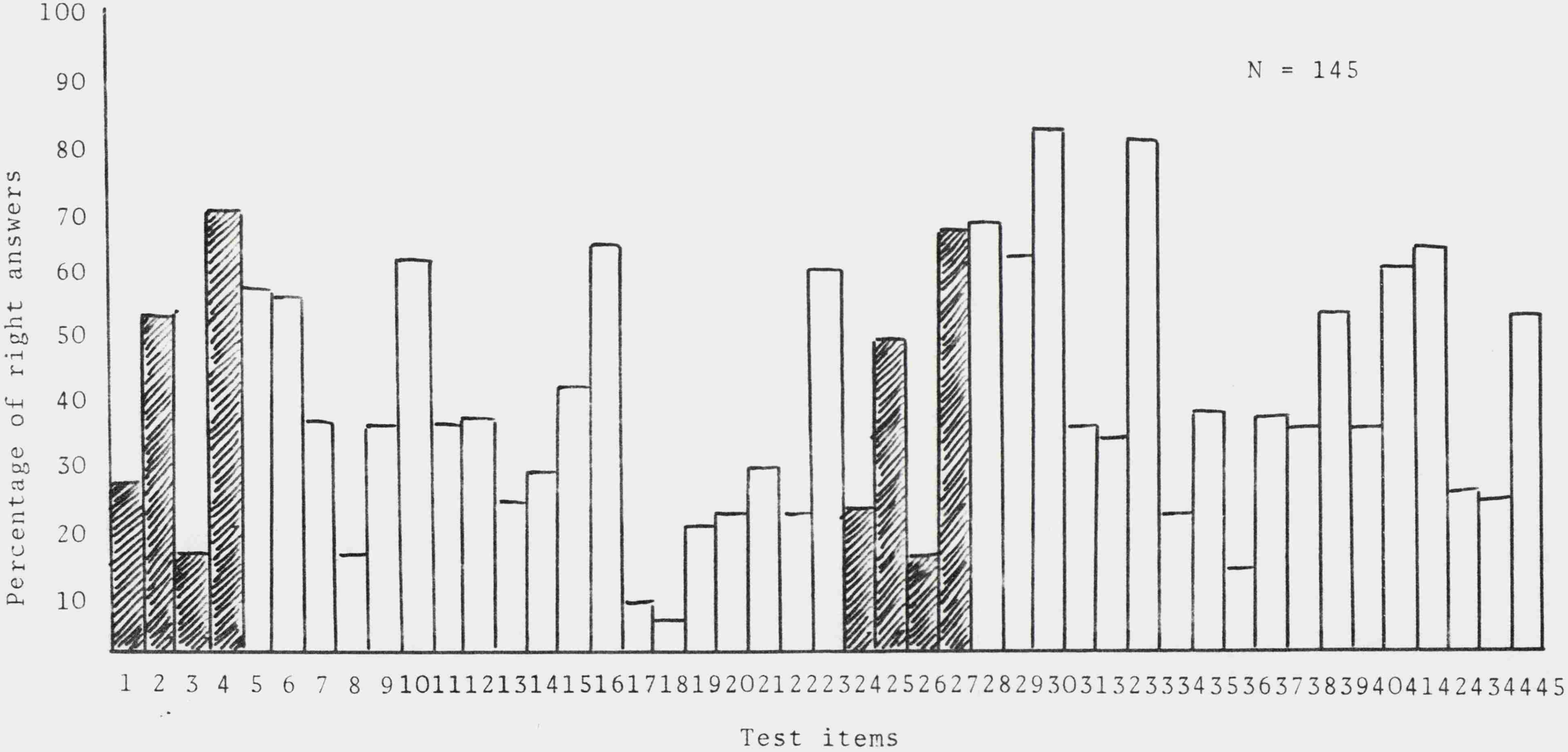
Name of school	Number of students in the test			Sex
	Form A	Form B	Total	
Babate (Tehran)	31	27	58	Male
Darius* (Tehran)	15	22	37	Male
Irandokht (Yazd)	23	22	45	Female
Iranshahr (Yadz)	25	29	54	Male
Mohammed R.Shah (Tehran)	25	26	51	Female
Shahriar 1/1 (Tehran)	26	29	55	Male
Shahriar 1/3 (Tehran)	25	26	51	Male
Total	170	181	351	F = 96 M = 255

*was omitted in the analysis.

Therefore, the sample of the analysis included 145 students for each Form or 290 for the whole population.

General results obtained from the ecology tests are represented in Figure 6.3. In this Figure, the four test items about Van Helmonts' experiment are repeated in both

Figure 6.4: Results of the Ecology Tests. Pilot Study. Questions 1-23, Form A. Questions 24-45, Form B. Reliability: Form A = 0.675 and Form B = 0.636. Shaded bargraphs represent the same questions in both test forms.



the test forms. The similarity of the shaded bargraphs indicate that there was a stability of their achievements. Further statistical evidence can be found in Appendix 1~~0~~3.

The pattern of the Form A shows it either contained more difficult questions or more ambiguous questions since no assumption was made about the difficulty of the text and the ambiguity could be corrected. The alternative explanation is the effect of the teaching methods on students' achievement.

Th e tests were studied by 20 teachers in various schools. They were asked to look at the items and decide if any of them were not about content of the textbook. They had also been asked to decide if their students could easily answer the text. These responses were used as a source of validation.

In interview with students and teachers, various flaws in the question items were detected. These ambiguities had led to the items becoming difficult items.

Discriminant index provided additional data for item improvement since negatively discriminant items were not desirable for criterion-referenced tests. (18).

A panel of Ph.D. tutors viewed the English version of the questions and helped the revision of the test prior to, and after its implementation.

The low reliability of the test was expected since items were content-objective congruence, and most of the students were expected to be able to perform most of the items.

6.2.4 Evidence from the Teachers

6.2.4.1 Teaching Methods

Teachers' methods varied but could be grouped as follows:

1. The teacher used to ask a student to read aloud from the text and he described that part of the textbook.
2. The teacher used to give a lecture about a topic. Then, at intervals, students could ask questions if they wished about certain parts of the lesson.
3. The teacher used to dictate a summary of the book prepared in advance by himself.
4. The teacher used to prepare some questions and answers on the basis of each chapter content to emphasize the points he considered worth knowing.
5. The teacher used to teach by the Socratic method of question and answer, supplemented by occasional demonstrations.

In the majority of the classrooms visited the following pattern was universal:

Sixty percent of the time, the teacher was the sole speaker. In twenty percent he exercised discipline or made students write down what he had written on the blackboard. In five percent of the lesson students were asking questions or the teacher was asking questions related to the previous lesson. The rest of the time was spent reading from the textbook.

This pattern of teaching was partly dictated by the shape of the classroom. In most of the classrooms visited, there was less than a metre of space between the front row of students and the blackboard. There was a small gap, or enough room for only one student, to pass between the rows of benches.

Most teachers were authoritarian and acted as the only source of knowledge. Most of the questions and answers between the teacher and the students were carried out between the few top able students and the teacher. There was no sign of teaching by enquiry or discovery method.

6.2.4.2 Biology Teachers and their Status in the Society

In recent years, the trends of change in the society and the system of education has had enormous effect on the role and status of the biology teachers. The rapid expansion of the secondary education and introduction of a new system of education, faced the biology teachers with over-crowded classrooms, and an incredible demand for teaching more than 40 hours per week etc.

Since the existing institute for training teachers could not provide the required numbers of graduates needed for employment at the Ministry of Education, the number of qualified biology teachers have always been very low in proportion to the number of students and the needs of the country.

To solve this problem, the Ministry of Education employed whatever manpower was available in the Society. One of these sources was the members of the Health and Welfare Corps in the military service whose functions were to improve the situation in rural areas. These young graduates with no teaching experience or wish to do so, were employed to teach various science subjects in secondary schools throughout the country. Another source of teachers were those with a B.Ed. degree in subject areas other than biology. They were given responsibility to teach the new biology curriculum where there was a shortage.

The Science Teachers' Association, which had independent status, but was supported financially by the Ministry of Education, was integrated into the Ministry of Education bureaucracy in 1972-1973. This policy created a situation where science teachers lost their independence as a non-political organization. Therefore, they had no function in decision making at the Ministry of Education.

The science teachers' official role was seen to be at the bottom of the hierarchy of power. Their function was dissemination of all the decisions taken by the central and local departments of the Ministry of Education.

This passive role of the science teachers, as well as biology teachers, created several kinds of reaction amongst underpaid teachers who were prohibited from resigning or even applying for other jobs outside the Ministry of Education.

In a recent seminar on The Teachers' Education in Iran Dr. Kardan,Dean of the Faculty of Education at the University of Tehran cited other factors for the decline of the status of teachers in the Society. (19).

1. The attraction of the private and non-governmental institutes for graduates who seek better financial and status situation in the Society has prevented the more clever students from applying for the teaching jobs.

2. The decline in the quality and standard of the teachers' education curriculum and the alienation of these institutes from the requirements of the Society.
3. The expansion of mass media and the effect of the educational television on students, who compare the quality of their teacher's instruction with what they see on television.
4. The ambiguity of the regulations and qualifications needed for the employment of the teachers and emphasis on the certification as the main requirement for being employed as a teacher.
5. The change of expectation, from the teachers, in the Society.
6. The increasing communication with progressive countries and awareness of the better methods of instruction.
7. The unsuitable conditions for teaching and learning in the present schools.
8. The unprofessional status of the teaching job.
9. The biased regulation for promotion and the existence of discrimination in the system.
10. The quality of the in-service courses that do not prepare teachers for what they were expected to teach in a school.
11. The increasing number of women teachers in schools, conflicting with the view of Man and Society in Islamic culture which alienates their functions.

These were applicable to the biology teachers' status and situation whose roles and functions were heavily influenced by these factors.

Another decision taken by the Ministry of Education introduced additional factors to the above list. New regulations by the Department of Examinations put emphasis on laboratory activities and continuous assessment. This was not comparable with the lack of equipment and apparatus, space and financial resources required for such activities. The lack of time allocated for doing laboratory work was increased by the necessity to finish the syllabus in the recommended timetable.

6.2.4.3 Teachers and the Biology Curriculum

(A) Teachers assessment: 50 samples of teachers' examination tests were collected and analysed. Eighty percent of the questions were concerned with "knowledge", and the rest with "comprehension". In most cases, the questions were short answer type, where pupils could describe the answer in their own language. Laboratory assessments were carried out orally or by written exam from what had been demonstrated or performed.

(B) Teachers and biology curriculum: A checklist for interviews with teachers was prepared to summarize various points that could arise in interviews. At an early stage it was decided to abandon any note-taking in the interview and record the whole interview immediately afterwards. The main reasons for this were as follows:

1. Teachers showed hostility when notes were made about their comments.

2. The items in the checklists caused distraction of teachers' attention answering interview questions. The main reason was the newness of the situation.
3. The checklist in this environment was very limited in its scope.

Most of the biology teachers had not seen the copy of the biology curriculum that was sent by the Curriculum Planning and Research Centre to the Regional Department of Education. Those who said they had seen such publication could not recall the exact content of this curriculum.

However, a list of the curriculum goals was given to the biology teachers and they were asked to rate their desirabilities and practicalities by using the scale provided. (See Appendix 7.) The analysis of teachers' responses revealed that the skill in using laboratory apparatus is the last item in the rank order (Table 6.5). This rank order also represents the reality of the teaching situation in school.

The dat~~e~~a in Table 6.5 show~~s~~ that:

1. Teachers were aware of specific goals (Nos. 7 and 8) and applied them in their school situations.
2. The use of laboratory apparatus was ranked very low in terms of practicality and desirability, showing that the present situation is not suitable for its implication.
3. Some desirable aims that reflected the teachers' ideal were not ranked high in their practicality, e.g. goal No.1.

However, the small number of this study did not permit further generalization for the results. But they emphasized that this enquiry should be followed up in the fieldwork study. (20).

Table 6.5: Teachers' rating curriculum goals.

Aims of the Biology Curriculum[1]	Desirability Rank Order	Practicality Rank Order
1. Development of scientific attitude	3	2
2. Development of interest to use scientific approach	4	3
3. Ability to fulfil his need by science	2	5
4. Acquisition of minimum knowledge	7	7
5. Development of skills in using laboratory apparatus	8	8
6. Familiarization with technical terms	6	6
7. Similarities and diversities exist among living creatures	5	4
8. Understanding the status of man in the web of life	1	1

[1] Details of these aims can be found in Appendix 1, p.245-247

(C) Unauthorized publication and teachers' guide: In 1973, when the biology textbook authors were preparing the textbook, they recommended to the Book Organization that a teachers' guide was vitally needed. Amongst the reasons they counted was the newness of the ecology in school and university curricula.

The Director of the Book Organization rejected this recommendation on the grounds that "the teachers' guide, for the Guidance Cycle books, were hardly used by the teachers. Let the biology teachers feel the necessity of the teachers' guide and ask for it".

In the following summer the subject of the teachers' guide was raised in all the in-service courses. Teachers who had found the subject difficult asked the Ministry of Education to report their view on the need for the teachers' guide to the Book Organization. This recommendation was never considered by the Book Organization.

Therefore, insecure teachers who had to deal with the innovation, ignored the suggestion of the authors to read references at the end of each chapter, and sought a short cut method to solve their urgent problem. Many created a passive methodology, i.e. forced students to memorize the text or dictated a summary of the chapters, etc.

A few teachers collected some notes from discussions made in in-service courses and supplemented them by what they could interpret from the text.

Two teachers printed textbooks called "Books of Knowledge" which were questions and answers about concepts and principles in each chapter. (21)(22). These books became popular by 1975 and affected many of the biology teachers' method of instruction.

In spring 1975, when the new regulation of the Ministry of Education provided a publication for obtaining credits for promotion at the top jobs at the Ministry, the second series of unauthorized publications appeared. These publications were mostly background reading for the biology teachers, extracted from various university publications.

6.3 Evidence from the Mass Media and Other Audience

The ecology curriculum affected various bodies in the Society and was affected by them as well. Most of these bodies were outside the boundaries of the Ministry of Education:

1. Media. One of the authors who was also the editor of the natural history films at the National Television persuaded the National Television to import several films on "survival" and other related subjects. The broadcasting of these films with Farsi translation was very helpful for the biology teachers and students.
2. Population Control and the Ecology Curriculum. In 1973, when the ecology curriculum was in the process of its development, the Ministry of Health was planning a campaign for population control. The ecology curriculum inspired the decision maker for this campaign and in special committee it was recommended that the question of human population explosion should be discussed in the textbook. This section was introduced in the 1975 edition.
3. Conservation of National Resources and the Ecology Curriculum. In 1973 the Ministry of Conservation of Environment and Natural Resources showed a great interest in the development of the

ecology curriculum. When finally the textbook was published the lack of any alternative resources led the Department to publish a small book called "What is Ecology" in 1976. This book was included in the references of the 1976 edition.

6.4 Summary and Recommendation for the Fieldwork

The application of the curriculum analysis and the goal analysis in the intrinsic evaluation not only provided comparative data about the curriculum and the textbook, but also provided various information that could be used for the development of varieties of instruments.

The description of varieties of curriculum effects, in the pilot study, is the result of application of illuminative evaluation strategy. The combination of illuminative and experimental design provided a more comprehensible data and the curriculum effects.

From all the evidence discussed in this chapter, it can be concluded that the fieldwork should follow the same methodology. At the time of the pilot study, innovation was at its earlier stage of development. Various discrepancies were expected. In the time of the fieldwork, not only the change of the system had been absorbed by the system but also students, teachers and administrators will be more acquainted with the management of the curriculum.

Therefore, it is recommended that in the fieldwork:

1. Evidence from the Society and the system of education should be monitored and described by the application of the illuminative evaluation strategy.

2. Evidence from the students should be carried out by interview and questionnaire. Their free responses and attitudes towards the ecology curriculum should also be investigated.
   The achievement test should be refined and used on a larger random sample population of students to reduce idiosyncracies of local effects. The students of the vocational school could be used as control groups. There was a need for more comprehensive evidence of reliability and validity of the test, apart from content validity.
3. Evidence from the teacher was best investigated by postal questionnaire from a group of randomly selected teachers who had taken part in in-service courses. Interview with teachers, after the completion of the questionnaire, was necessary to clarify various points they had made.
   Visits to the classroom and observation of the teaching methods were necessary to confirm the result of the pilot study.
   Various issues arose in the pilot study, hours of teaching, low status of teachers, low salary etc. These should be investigated in the teachers' questionnaire to supplement the illuminative evaluation of the same evidence.
4. Evidence from schools should be carried out in the same way as was used in the pilot study. Laboratories should be visited and be evaluated for their potential usefulness for the ecology curriculum.

5. The evaluation design should, apart from the experimental instruments, be flexible, to enable the investigator to monitor unintended effects of the curriculum. This could be achieved only by the illuminative evaluation of varieties of effects.

Finally, the results of the pilot study showed that the model of curriculum evaluation was operating quite well for evaluating the objectives defined in chapter five.

References and Notes on Chapter 6

1. The term "Curriculum Climax" was used in the same context as ecosystem climax. This analogy was possible when we considered both systems as a set of parts co-ordinated to accomplish a set of goals. In ecosystem the goals are goals of a living system, whereas in the curriculum, curriculum materials replaced the original living system which created them. The goals of the curriculum, in this context, are those intended and unintended goals which create curriculum effects.
   Curriculum innovation undergoes succession. Its intrinsic characteristics interact with factors out of the curriculum, i.e. students, teachers, society, etc. In the process of this succession, innovation passes through intermediate stages, each called a curriculum climax. A curriculum climax, at a certain period of time, varies in varieties of educational environments.
   By this notation, it is implied that the hidden curriculum is the natural outcome of every curriculum innovation.
2. ERAUT, Michael. *et al.* (1975). *The analysis of curriculum materials*. University of Sussex, Educational Area, Occasional Paper No.2. p.14. Sussex: University of Sussex.
3. *Ibid.* pp.32-54.

4. The main reason for this failure was that the Guidance Cycle combined science textbooks were authorized translations of three American textbooks. Any change in the sequence of these books would affect the sequence of the materials in the later volumes.
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11. *Ibid.* p.15.
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13. *Ibid.* p.16 and pp.17-33.
14. *Ibid.* pp.8-12 and pp.34-60.
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19. KARDAN, A.M. (1975-76). Reasons for decline of the status of the teacher in Society. *Journal of Faculty of Education*, University of Tehran, 5, 2, 161-167.

20. This scale became part of the teachers' questionnaire in the fieldwork study. See Appendix 7.

21. BEHDAD, M. *et al.* (1975). *Behdad's Knowledge book for students in the final year of the academic secondary schools*. Tehran.

22. DAII, A. (1975). *A West collection of science for the use of the students of the first year of the academic and comprehensive education*. Tehran: West Publishing Co.

CHAPTER SEVEN

EVALUATING THE NEW BIOLOGY CURRICULUM IN IRAN

The new biology curriculum was implemented in a period of time in which both the system of education and the socio-political system of the country were in a process of rapid change. In its formative years of development, the goals and the content of the new biology curriculum were affected by these changes.

The investigation into the original curriculum that was implemented in 1974, was confined to one topic, namely ecology and was restricted to cover its development in the first year of the secondary schools. The continuation of the changes in the society and educational systems affected the implementation and dissemination of this curriculum as well. In the following chapter evidence from the society, the educational system, teachers and students has been used to explain the effectiveness of the new biology curriculum in its new context. The discussions are also based on the information described in the pilot study.

In order to emphasise the main issues many of the technical reports and data have been allocated to the three Appendices, 13 to 15. Readers are, therefore, recommended to read the present chapter in conjunction with those appendices if they wish to obtain more detailed information about each issue discussed in the chapter.

7.1 Factors Affecting Educational System in Iran

The present trends in the Iranian system of education indicate that the national aim is the creation of a unified nation. The use of one official language for learning and instruction, the expansion of the educational system, the campaign against illiteracy and the political control of the mass media are all directed to replace indigenous cultures and languages by an Iranian culture and language.

This reformist policy also encourages the growth of the rapidly expanding industry. The need for increased manpower in this sector necessitates revision in the system of education. The emphasis on technical, vocational and comprehensive education and the massive investment on these institutions indicates that rapid industrialization of the country has dominated the educational system.

All these changes are masterminded by the Monarch, whose ideology of reaching to the "great civilization" has been repeatedly expressed in various sources. He has implemented his ideology through manipulation of a group of elites who have occupied key positions in the country and have been able to influence various systems within the society.

7.1.1 The Monarch and his Role in the System of Education

The political leader and what he has in mind about the role and function of the educational system is very crucial in the way an educational system changes.

Historically, the Monarch has always enjoyed a high cultural and religious status. In the pre-Islamic period, the Shahan-Shah (King of the Kings) was the absolute power in running the state affairs. He was supported by the religious leaders and the religious instructions.

The local Kings, who were being appointed by the Monarch, had the same power in their respective states but were responsible to the Monarch for their actions. In contemporary Iran, the same type of hierarchy of power and control exists except that the Kings have been replaced by political elites (see Chapter 1, Figure 1.1).

From religious points of view, the Monarch has always been the head of the religion, the "light of God" (1). In the Islamic period this religious status was revived and further elaborated. In the *Shi'a* sect of Islam the twelfth Immam is believed to have absconded. The leader of the country, the Monarch in this case, is considered to be his representative on earth to guide the nation. Thus, the concept of Monarchy has acquired priestly and divine overtones. (2).

The implication of the religious view of the function of the Monarch is that he is immune to criticism. If something goes wrong he is not to blame, but the fault is alleged to lie with those who misinterpreted his orders. This concept of management and decision making is also duplicated in the bureaucratic organization. In most cases the employees are reluctant to act independently by using -their initiative. This is because they feel there can be either of two consequences: (a) if everything goes well it will be interpreted as a sign of good understanding of his superior's ideology; and (b) if something goes wrong one will think that it must have been his fault.

In the last 26 years the Monarch has introduced several socio-political reforms to facilitate implementation of his ideology in changing Iran into an industrialized and unified nation (see Chapter 2 for the details). The most outstanding of these reforms have been:

1. The land reform (1963) and liberation of peasants from the old feudal system.
2. The creation of the army of knowledge (1963) which aimed to literate the newly liberated peasants who formed 60% of the total population.
3. The administration and educational revolution (1968).
4. Free education (1975).

These reforms were all aimed to modernize the socio-economic as well as educational life of the country and ultimately direct the country to the "Great Civilization".

During the past ten years, several changes in the system of education have occurred. These changes have generally originated from the dissatisfaction of the Monarch with educational achievements that were reported to him. The most unsatisfactory area has always been the development of the technical education. (3). As the result of the Shah's dissatisfaction, and the interpretation of his view by educational elites, the system of education at the secondary level changed three times and once the officials responsible for various departments were removed.

The above changes at the formative stage of dissemination of the new system of education, and the nature of management and policy making in the Iranian system, severely affected implementating the new curricula, including the new biology curriculum.

7.1.2 Elite Groups and their Effects on the System of Education

There are three groups of elites that disseminate and implement a Monarch's ideologies:

1. Political elites: The political elites in Iran are those who influence the socio-political spheres as well as the political orientation of the country. They are directly acting under the leadership of the Monarch. The function of the political elites in terms of dissemination of the Monarch's ideologies is reminiscent of Plato's 'Republic' where, under the leadership of the philosopher-king the member of ideal state endeavoured to create a 'just' state, a kind of Utopia. (4).

   The establishment of one party system and the elimination of an opposition party in 1975, provided a channel through which the Monarch and his political elites kept their close contact with representative groups of the intellectuals. This policy also presents the effect of the ideas of the potential opposition groups who are brought into the party system to provide their services for the state welfare.

   In terms of education, the party (Rastakhiz) emphasizes the teaching of 'political education' as an essential part of the school curriculum, to disseminate the Monarch's ideologies amongst the students.

2. <u>Religious elites</u>: The religious elites in Iran have gradually come under the control of the Monarch and his political elites. They have lost their autonomy in running the country but maintained their role in moral and religious education. After the 1963 reforms, several attempts have been made to review the Islamic-Iranian cultural values and norms which could facilitate the modernization of the religious beliefs and justify recent educational and socio-political changes:

   (a) The education of the religious elites have recently been scrutinized, and a new curriculum was implemented at the reorganized higher education institute, i.e. Imperial Academy of Philosophy. Most of the emphasis in this curriculum is based on philosophical orientation of the curriculum.

   (b) The religious instruction was revived at all levels of the school system and new textbooks were written. These new textbooks introduced new approaches in studying Islamic culture and system of values. They were aimed to prepare students against the invasion of the western cultural ideology and system or values.

   (c) All the religious schools joined the public schools and were made to follow the same curriculum. The remaining *Madrasa* were shut and replaced by modern schools.

3. Educational elites: The educational reforms initiated by the Monarch are mostly interpreted and implemented by the educational elites. This group mostly consists of educational administrators and professional educationalists. They are those who contribute to various top educational committees and conferences under the leadership of the Monarch. The most important of these conferences has recently become the "Ramsar's Conference on Evaluation of the Revolution in the Education" in which educational elites exercise their interpretation of the Monarch's ideology and challenge others' views to reach a compromise. The recommendation of this seminar is the source of operational reform in the system of education. They are further discussed by the "Higher Committee of Education" at the Ministry of Education, and a uniform strategy for implementation is adopted by all departments to initiate the reform.

7.1.3 The Educational Control and Policy-making Institutions

The top policy-making body in Iranian education is the "Imperial Council on Education". The Monarch is the chairman of this council. The Empress Farah is the vice-chairman. This council provides guidelines on the aims and general aspects of the educational system in the country.

The aims projected by this council are interpreted in an annual conference, "The Ramsars' Conference on Evaluation of the Revolution in the Education" to formulate operational interpretation of these aims. (5). The conference issues various charters and reports which, after approval by the Monarch, are used for planning or reforming the educational systems.

The Ministry of Science and Higher Education is responsible for all activities related to the higher educational institutes in the country. This Ministry and the University Council coordinate the curricula, entrance examinations etc. in universities.

The Ministry of Education controls all the educational establishments below tertiary education. This Ministry has a "High Council for Education" which regulates the school curricula and examination regulations. All the teachers are employees of this Ministry.

In 1977 the above two ministries were merged to create a unified Ministry of Education responsible for all of the educational institutions and activities in Iran.

The school curriculum is developed by the "Curriculum Planning and Research Centre" at the Ministry of Education. Upon approval by the High Council for Education, it is sent to the Book Organization to be translated into textbooks.

The Book Organization consists of a group of specialist editors who control the contents and the style of the textbooks.

The Department of In-service Education is responsible for organizing in-service courses for teachers of all levels to prepare them for teaching the new curricula. There is a close cooperation between this department and higher education institutes.

Teachers training for various levels of the educational system are carried out by different institutes. Separate departments at the Ministry of Education are responsible for their bureaucratic affairs (see Chapter 2, pp.37-40).

The Ministry of Education consists of a central ministry and various departments. The same type of organization is duplicated in regional educational departments.

In a state capital city the Department of Education has several offices, each responsible for various aspects of the educational system. The department is run by a general director who is appointed by the Ministry of Education.

In a regional educational department, the secondary educational office is responsible for secondary schools. It supplies teachers, resources and studies their progress and difficulties - in short, their day-to-day problems. Secondary schools are mostly responsible to this office in particular, and the Department of Education in general. Teachers are at the bottom of the hierarchy of power and decision making. They are sent to schools to teach that which official curriculum requires them to teach.

Inquiries about the new curriculum are usually expressed in in-service courses. In these courses teachers come face to face with experts from the Department of Curriculum Planning and Research Centre or Book Organization etc. On the other occasions their inquiries and complaints pass through the filtration of regional offices, Department of Secondary Education, until they reach the responsible subject specialist. There is nothing to prevent them from making direct contact with top decision makers. The impact of these contacts, however, are not officially effective.

7.1.4 The School Environment and Regulations

Most of the secondary schools in state capital cities are rented buildings which have not been built for the purposes of schools. They have small yards with asphalted surfaces, little vegetation except for perhaps one or two patches of ornamental garden. In the building, classrooms are small. When the school is located near a busy street, classrooms are noisy and are affected by dust, heat, wind etc.

In old schools, and public-owned schools, the image is different. There is usually a big yard with some trees and several gardens. The sports area is moderately equipped. There is usually a football court and a volley ball court. There is also enough space for other recreational purposes. Classrooms are big and spacious.

In terms of the educational equipment and materials, all types of schools are poor. In few schools there is a room allocated for a library. In most schools the few books on religion, literature, history etc. were kept in a cupboard in either the headmaster's room or teachers' commonroom. The number of science books are few and scarce. (6). The existence of a rigid and complicated system for borrowing books mostly prevented students from trying to borrow them. Only two or three exceptions were noted throughout the 43 schools visited. In the capital city, Tehran, 28% of school libraries were found to have a similar system. In addition, the degree of reading books, other than about school curriculum, decreased as students reached the sixth grade. (7).

There are few schools having an operational laboratory. In most schools laboratory equipment is kept in a cupboard. This equipment consisted of a few physics and chemistry apparatus and one or two models and charts for biology. Some schools have one microscope and little apparatus for doing experiments.

In every state capital city there was a central laboratory. This laboratory was run by a technician. Several neighbouring schools used to send their students of different grades to this laboratory to be shown certain experiments or films. These experiments were not necessarily about what students had studied but were limited to the use of materials and equipment that were available.

The inclusion of a laboratory mark in the school regulations had made the use of these central laboratories very popular.

Schools are open from 23rd September until 22nd June in the following year. There is a 20-day holiday at the beginning of spring and three months' holiday in the summer.

There is one written examination at the end of each academic term. The third term examination carried a double credit and the average pass of the examination mark obtained for specialist courses must be above 12 out of 20. This criterion is 7 out of 20 for other subjects. Those who fail in one or a few subjects may repeat their written examination in September to raise their average total mark to the pass score.

The total average mark for the biology course consists of the results of the three written examinations, some oral examination and a laboratory mark.

7.1.5 The New Biology Curriculum and its Changes

The new biology curriculum implemented in 1974 was originally a two-year course. This curriculum was planned to be taught at the two years of general secondary education in the 1974 system of education (Fig. 2.3, p.34). In the following year, the system of education at the secondary level was changed and the general secondary education course was reduced to one year of study (see Fig. 6.3, p.153).

This change caused the omission of several topics from the biology curriculum. The remaining topic, ecology, was combined with the subject hygiene in a single textbook and called the biology textbook. This book has two sections: the first section is about ecology and the second ~~biology~~ hygiene.

In the years following 1974 the content of the biology textbook underwent several changes. The 1975 edition was only concerned with changes in the illustrations and a few errors. In 1976 the sequence of chapters was changed to provide more time for students to improve their knowledge of chemistry before studying the chapters on producers and consumers (see Chapter 3 for the details).

7.2 Method of Studying the Biology Curriculum Effects

The study of the biology curriculum effects was conducted in two stages. During 1975 an intrinsic evaluation of the curriculum materials provided data on the details of the content and goals of the curriculum materials. The pilot version of the instruments were developed on the basis of these data.

In the pilot study (15th April until 15th May 1976) various data on the society, system of education, was collected. The early version of the instruments were tested, on a representative population, and various interviews with officials, teachers and students were carried out (see Chapter 6).

In 1977 (between 15th April and 20th May) the same strategy for data collection was repeated. The revised version of the achievement test was tried in 43 schools and in each individual case it was supplemented by an interview and questionnaire to obtain data from a group of randomly selected students. Some interviews with teachers were arranged to clarify certain points arising from the results of their questionnaires (Appendix 14, pp.501-540).

On the whole, the method of study was a marriage between illuminative and experimental methods of evaluation. In this study evidence from the curriculum, society, teacher and students were comprehensively used (see Chapter 5 for more details).

7.3 The Population of Samples

The population of samples refers to the samples used for experimental design. Different samples were used for various instruments:

7.3.1 The Population of Samples used for Achievement Test

These students were selected by the application of a stratified random sampling technique from a manageable population of students (Appendix 13, pp.409-500).

(A) <u>Experimental group</u>. This group consisted of students from the first year of the academic secondary education in four state capital cities and 43 schools. They were studying the new biology curriculum and were all 14-15 years old.

(B) <u>Control group</u>. The control group consisted of students from the first year of the vocational secondary education. They were usually housed in separate schools and studied no biology in their school curriculum. Their characteristics, i.e. age and their biology backgrounds were matched with the experimental group.

(C) <u>Whole-test group</u>. The whole-test group contained the same students as those in the experimental group who tried both forms of the biology achievement test.

(D) <u>Pilot study group</u>. The pilot study group were those students who tried the first version of the achievement tests during the pilot study.

Table 7.1 shows some details of the above samples.

7.3.2 <u>The Population of Sample used for Students' Questionnaire</u>

These students were randomly selected from the population of the top students in each of the experimental groups. (Table 7.1). More details about this sample can be found in Appendix 15.

7.3.3 <u>The Population of Sample used for Teachers' Questionnaire</u>

These individuals were randomly selected from a list of the teachers who had attended a special in-service course for teaching the new biology curriculum (Table 7.1). Out of 266 teachers who were sent the questionnaire, 151 questionnaires were returned, and 147 of them were used for the present study (see Appendix 14, p.510 for more details).

Table 7.1: Details of various population samples used in the evaluation of the biology curriculum in Iran.

Category	No. of Samples	No. of Students
1. Achievement test:		
A. Experimental group	43	1851
B. Control group	6	312
C. Whole-test group	10	584
D. Pilot study group	6	290
Total	65	2937
2. Students' questionnaire	43	130
3. Teachers' questionnaire: 151 respondents, 58% of the total population of sample		

7.4 Evaluating the New Biology Curriculum

The new biology curriculum was developed in the environment described in the above pages. The intrinsic evaluation of the curriculum goals and materials (Chapter 6) showed that unless the book was properly taught, the curriculum goals could not be achieved. There are several activities in the textbook that must be exercised in teaching if the curriculum objectives are to be attained.

The curriculum analysis also revealed that there was an intrinsic sequence in the content of the textbook which could have been crucial in learning some of the basic concepts. The change of this sequence in 1976 facilitated the learning of some of the concepts on photosynthesis but might have affected the process of learning others. A formative and continuous evaluation programme is required to evaluate the validity of this hypothesis.

Evidence obtained from curriculum, students and the teachers is discussed in general terms below. Detailed discussion and data about each specific point can be found in the appropriate appendix on each of these factors (Appendices 13 to 15).

7.4.1 The Curriculum Materials

The curriculum materials of the new biology curriculum was only a students' textbook. This textbook consisted of the following parts (see Appendix 3 for the details of the textbook content):

1. The text and experiments.
2. Chapter summary.
3. Questions and self assessment.
4. Activities outside the classroom.
5. References.

The inclusion of experiments as an integral part of the text was aimed to persuade students to rediscover simple scientific facts and develop a scientific attitude.

The questions and self assessments were measuring the attainment of the chapter objectives achieved by the students. The chapter summary emphasized the main concepts and principles introduced in the chapter.

The inclusion of additional activities under the title of "activities outside the classroom" was to provide students with the application of the biological investigation in their daily life.

The references were carefully chosen from the readily available (in 1974) publications in Farsi. These books and articles could not only provide more information about the chapter context but also could satisfy questions that inquisitive students might like to ask about various aspects of the chapter in question. They also led to additional references.

These aspects in the biology textbook were all innovations that had never been implemented before in Iranian textbooks. It was hoped that the textbook and its accompan~~led~~ying teachers' guide could provide some materials for teaching and learning that could lead to the attainment of the curriculum goals and objectives.

The goal analysis of the curriculum goals and those attributed to the textbook showed that most of the curriculum goals could be achieved if the textbook was taught in the way that was recommended.

Teachers' responses to the teachers' questionnaire showed that the degree to which the above goals had been attributed to the biology textbook varies (see Appendix 14, Table 14.2) but some of them depend on the availability of the equipment and materials, and the conditions that will be discussed in the following.

7.4.2 Students' Achievement

Several instruments and methods of inquiry were ~~was~~ used for measuring students' achievement. To assess students' cognitive achievement, evidence was derived from the results of the achievement tests, students' questionnaire and interviews.

The attainment of the affective objectives of the curriculum were measured by employing two items in the students' questionnaire, interview, free responses and evidence obtained from the literature. The attainment of the psychomotor objectives were judged by observation of the classroom, school laboratory, interviews with teachers and students and examining students' practical work and workbooks (Appendix 10, Tables 10.7 and 10.8, for the details of affective and psychomotor objectives).

7.4.2.1 Cognitive achievement

The biology achievement test used for measuring students' cognitive achievement was a criterion-referenced test. This test was developed in the pilot study and was reviewed and revised before being applied in the experimental work. The test consisted of 45 questions. 42 of these questions were multiple-choice items and 3 were short-answered questions.

The test items were validated for descriptive and functional validity (see Appendix 13 for the details). The results obtained from the four groups in the sample are represented in Figures 7.2 to 7.5.

Figure 7.2 : Frequency polygons showing boys' performance in the control group and the experimental group for the biology test Form A and teachers' examinations.

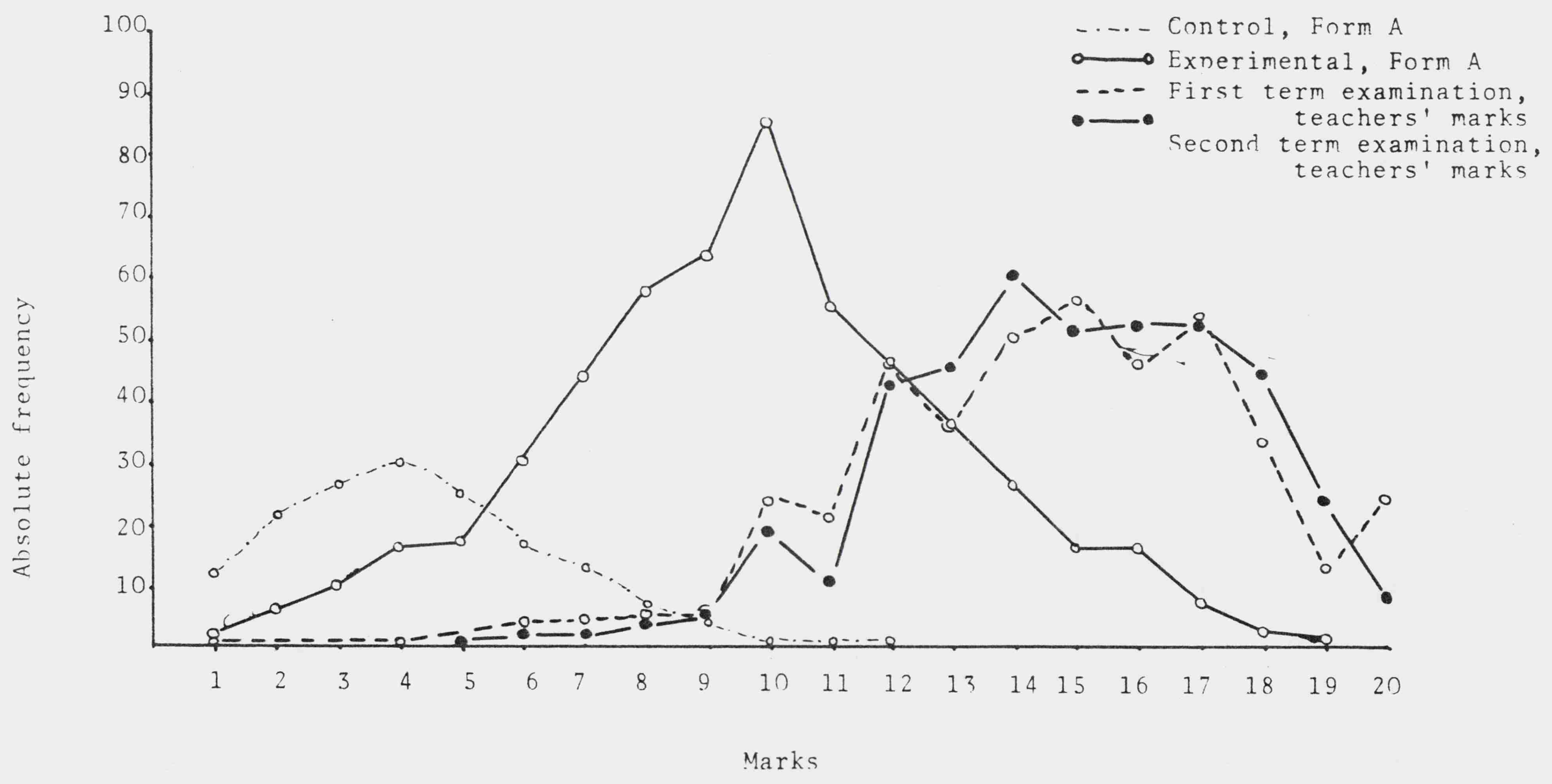
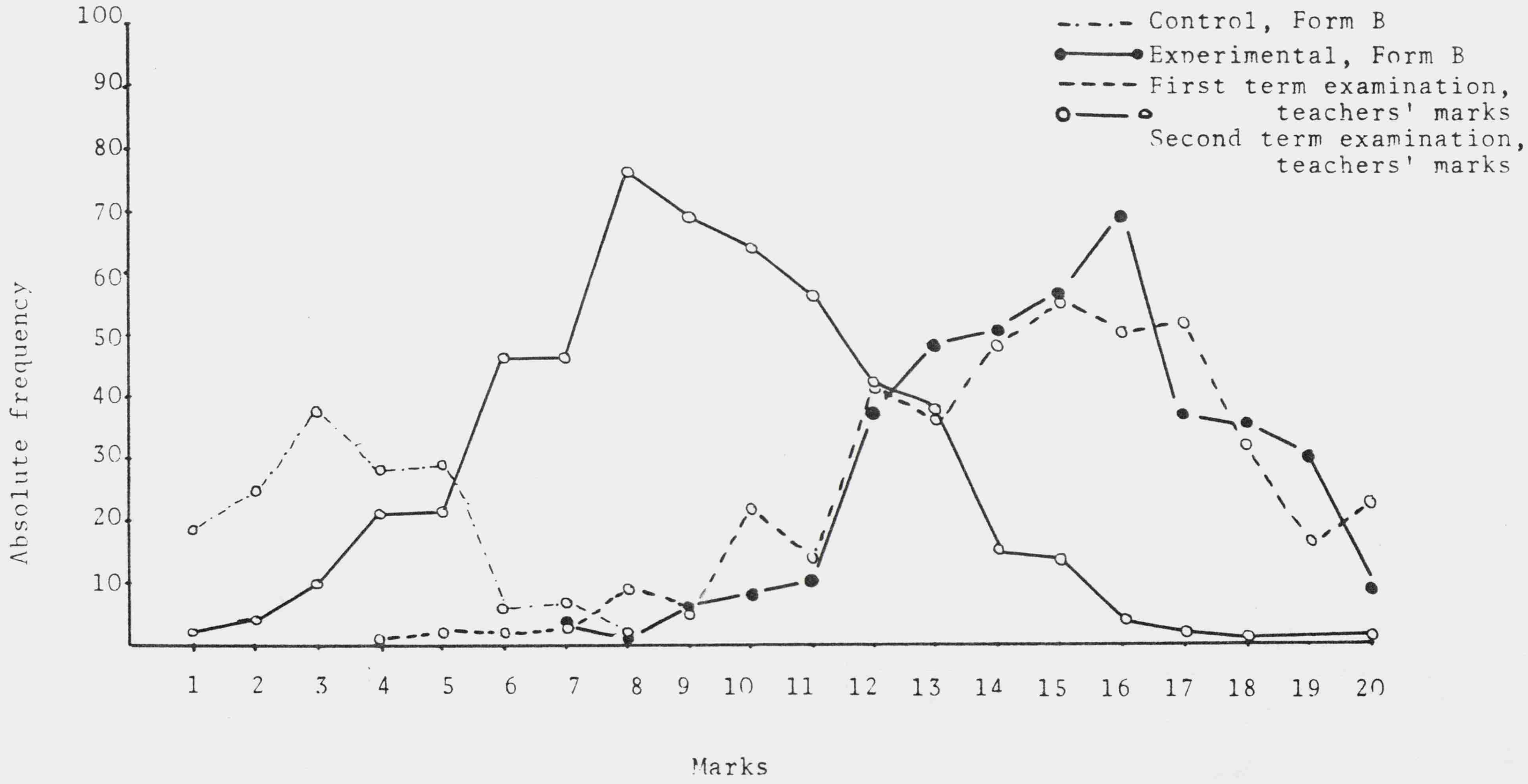


Figure 7.3 : Frequency polygons showing boys' performance in the control group and the experimental group for the biology test Form B and teachers' examinations.



<u>Figure 7.4</u> : Frequency polygons showing girls' performance in the control group and the experimental group for the biology test Form A and teachers' examinations.

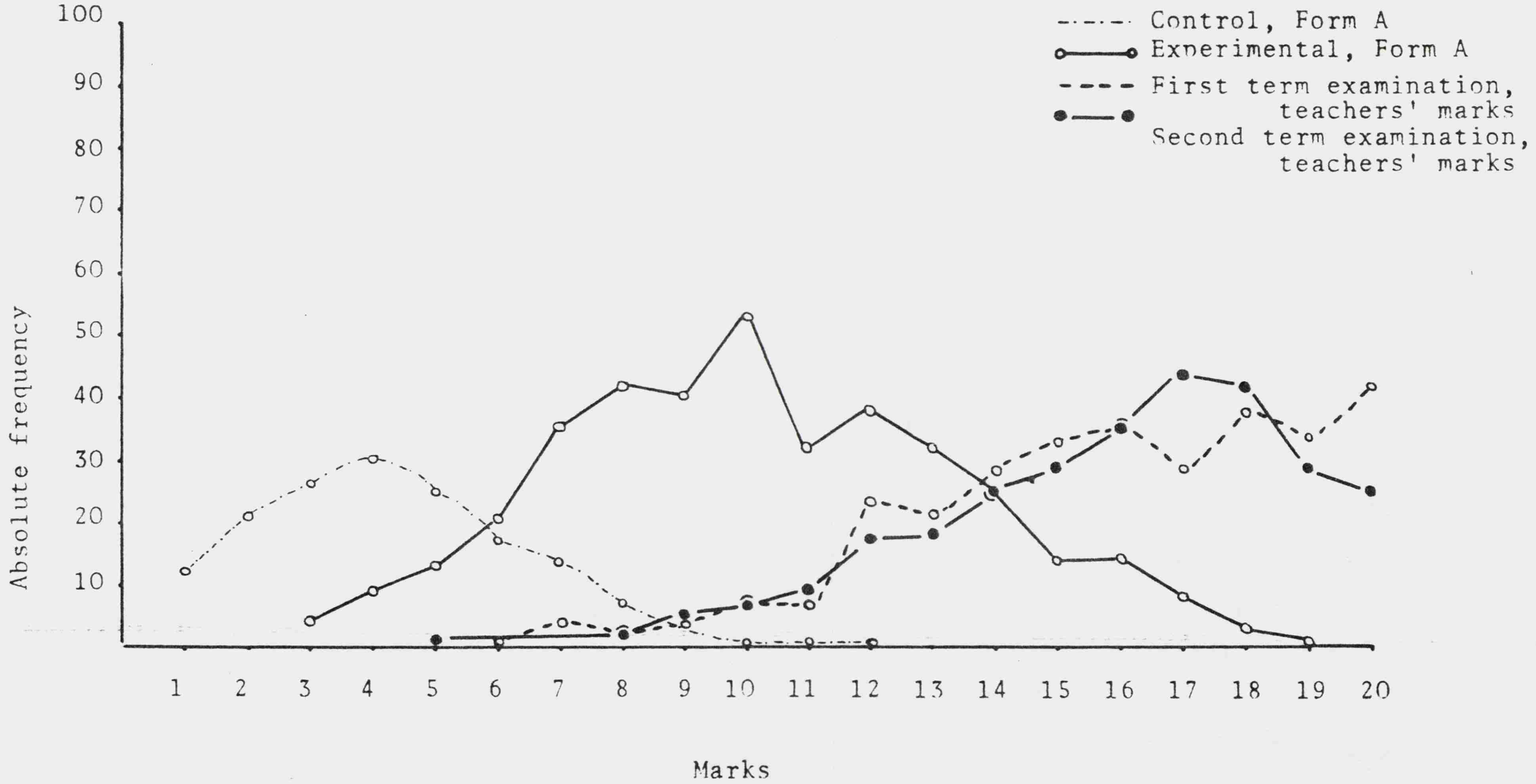
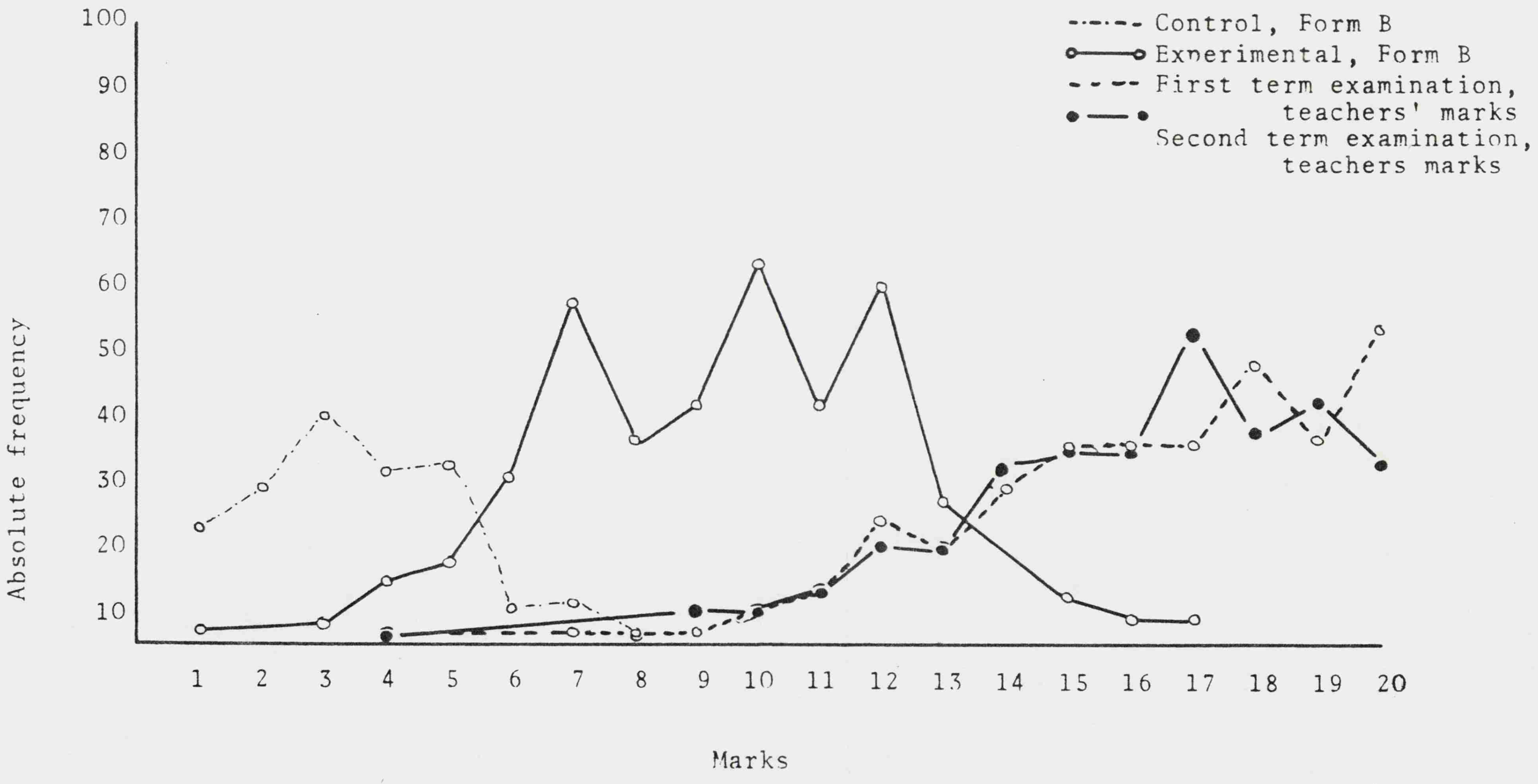


Figure 7.5 : Frequency polygons showing girls' performance in the control group and the experimental group for the biology test Form B and teachers' examinations.



Study of the details of these results shows that:

(A) The frequency scores obtained from the biology tests has a regular and normally shaped distribution. The scores of the teachers' examination marks are skewed. The score frequency of the control group is balanced to the left and never contained a pass mark (12 out of 20). However, the shape of the score distribution is normal.

(B) Comparison between the results obtained from boys and girls shows the frequency polygons of the boys' scores are more regular but leptokurtic, suggesting that their achievement scores are normally distributed and they had a more consistent instruction. None of the test forms showed any bias for sex nor different areas as was established in the sampling procedure (Appendix 13, pp.449-455).

(C) The teachers' marks for the internal examination were biased for sex and also had a higher mean value in the second term than the first. The boys' marks had less variance than girls, suggesting they had a more consistent instruction than the latter.

The results obtained from the teachers' examination marks showed between 84-93 percent of the students had obtained scores more than 12 out of 20. The girls had higher scores and their mean value for the second term examination marks was even higher than the first term.

Interview with the students and the teachers, evidence from the educational system, and various other data (Appendix 13) suggested that there might be several reasons that lead to these marks:

(a) In most cases, teachers in the girls' schools are the men who believe that, since most girls marry and leave school early, there is no need to scrutinize their depth of understanding. They give easier or essay type questions to the girls and keep the more difficult questions for boys' schools where students have more interest to challenge by difficult questions.

(b) The degree of bargaining that was taking place in girls' schools to scrutinize the details of their examination marks, and the amount of materials they should have studied for term examination, was higher than in boys' schools.

(c) It was a general belief that girls were better in rote memorization than boys. Most of the teachers' test items also concerned measurement of the attainment of "knowledge".

(d) The reason in (a) above caused many teachers to be selective, more selective than in boys' schools, in their choice of the materials that they were teaching.

The results obtained from the biology achievement test showed that, for each mark, boys had acquired a higher frequency than the girls. But the distribution of their scores were spread over more range of marks than it was in the girls' score. The lack of sex bias or bias for areas seems to disagree with the above hypothesis, but looking at the facility of individual items showed that usually girls obtained a higher score on items measuring knowledge than the boys. The loss to boys was mostly on items designed to measure comprehension and application.

This result shows that in the population under study and the environment of teaching and learning the boys achieve higher cognitive objectives better than the girls. It follows that for the same reason girls did better on the teachers' test than ~~girls~~ boys, if we accept the claims from the teachers that they gave questions on lower level of abilities to girls.

The second characteristic in teachers' marks was that students did better in the second term than the first term. Normally the second term examination is the examination of the whole area studied in the two terms. But, studying the examination questions and interviewing the students, showed that this was not the case. Teachers and students have reached, in most of the cases, a certain agreement. Only materials taught in the second term were examined, and students had to memorize a selective part of this material.

(D) Study of the school by school achievement of the test items showed that bargaining on teaching and learning materials is an intrinsic characteristic of the system. Since in every school certain items were achieved by most of the students or missed by all (see Appendix 13, Fig.13.31).
The results from observation of the classroom showed that in very few schools was the classroom in a position to be used for group experiment on activities related to the exercise of the discovery method as advocated by the curriculum objective for teaching and learning.
In the few schools where a library existed, there were very few books on science. The same applied to the existence of laboratory equipment and materials. There were crowded classrooms and very little space left in schools for other activities. In many bigger schools new buildings were erected where the football pitch was located, so extra classrooms were being built to replace sport courts. Because the price of land was very high and the number of students was increasing, there was no land in other parts of the town belonging to the Ministry of Education. On the other hand, sport was never considered to be an important activity of school life.

The imposition of the laboratory mark had forced the biology teacher to adopt any of the several alternatives discussed below:

1. To do some group experiments.
2. To demonstrate some of the experiments in the classroom.
3. To ask students to do the experiments at home and write the results in their notebooks.
4. To send students to a central laboratory.
5. To take them to local hospitals for showing some experiments.
6. To ask a few interested and inquisitive students to read one or two of the references and give a short conference about them.
7. To persuade a few enthusiastic pupils to make models, collect leaves, flowers etc.
8. To duplicate the examination mark for the laboratory examination grade.
9. To show films, slides and charts, models, and ask students to write about certain aspects of these audio-visual materials.

At the end, it depended on the teacher and his method of instruction to decide which methods above should be used for providing laboratory marks. In the majority of schools one or two of the above activities were taking place. Most of the experiments were carried out by students. Those who had read a few reference books did not perform it due to their teacher's recommendation but their own initiative.

The television programmes that specially were shown for the students and teachers were only watched by a few interested students, and were never used by the teacher in his class discussion because he had no time to watch them since he was working in the evening.

7.4.2.2 <u>The affective and psychomotor objectives</u>

There were few affective and psychomotor objectives that could be at~~tr~~ibuted equated to the effect of the biology textbook (Appendix 10, Tables 10.7 and 10.8).

Students' attitudes towards the ecology syllabus was mixed. They believed that science and scientists can only be found in a laboratory. They did not contribute the study of ecology to the scientific enquiry (see also pilot study, pp.160-162). In a recent study of the scientific attitude of the secondary students in the new and old systems of education, similar data was obtained. (8).

1. Boys were shown to be more science-minded than girls.
2. There was no difference between students' attitude to science in the population of samples obtained from the new and old systems of education.
3. Students agreed with both scientific and non-scientific statements in the attitude scale.

The above results showed that students' attitudes were formed as the result of the rote memorization of what their society and school system dictated them to learn.

In a few schools, students had prepared a workbook in which simple diagrams from the blackboard or the textbook was copied. These diagrams used for teaching and learning and students had to be able to draw them accurately. No other psychomotor objectives were noticed elsewhere.

7.4.3 Evidence Obtained from the Biology Teachers

Evidence obtained from the biology teachers was mainly obtained from their interviews and the questionnaires and class observation. The interpretation of these results was carried out by the consideration of the interaction existing between the biology teacher and the environment of his teaching.

The number of biology teachers in the sample was 147. These teachers were mostly married men. The small proportion of women teachers reflect the traditional inequality in educational and social opportunities that have existed in the past. The biology teachers in the sample had teaching experience of between 2 and 28 years. Those with less than 10 years teaching experience were residents of the capital city in which they first started their teaching career. Some of the older teachers had come from other cities. These latter cases reflect the effect of the Ministry of Education regulations that teachers cannot apply for being transferred to another city unless they had fulfilled at least five years of teaching in the first place they had been employed. The results obtained from the society and Ministry of Education shows that these regulations did not prevent the older and more experienced teachers from migrating to state capital cities, especially Tehran. While the shortage of teachers in the country is estimated to be ~~75000~~ 57,000, in state capital cities the shortage of science teachers is not as acute as in other cities and towns in the country.

Teachers in the sample were mostly graduates from the National Teachers' Training College, a Faculty of Education, or a Faculty of Science. They had various specializations which was the reflection of the nature of their degrees. However, details of the subjects that they were teaching showed they teach many subjects outside their specialization (Appendix 14, Table 14.7). On the whole, most of the variation in what they were teaching can be attributed to the existence of the old system of education alongside of the new one.

The biology teachers were all teaching more than 36 hours in a week. Officially a biology teacher's salary is based on 24 hours of teaching. He can choose to be a full-time teacher by accepting another 12 hours of teaching in a week. In reality, since schools run 6 days a week and some schools have four sessions (of 50 minutes' duration) in the morning and in the afternoon, the opportunity of teaching more than 36 hours is provided. Especially after the introduction of free education (1975) the number of students and consequently the classes in science and technology increased and created a great demand for science teachers. As the result of this event most of the biology teachers were teaching varieties of related subjects in varieties of schools. They were, moneywise, quite contented (see Appendix 14, Table 14.11).

The choice of the teachers for teaching at a certain level in the education system, however, could be related to the following causes:

1. The differentiation of tuition fees for different levels of the system of education had made the higher grades more attractive than the others. Most of the teachers' effort was towards allocating their official sessions to the lower grades and spending more of their spare time on higher grades to obtain more income.
2. The official status of a grade had made it more attractive than the others. At the moment the last years of the secondary school are prepared for a national examination. The result of this examination is decisive in obtaining: (a) secondary school certificate; and (b) to take part in a university entrance examination; and (c) to enter the job market. Also, the result of this examination is interpreted as a measure for teachers' performance as a whole. If more students in his classroom pass the final examination and the university entrance examination, then the teacher is considered to be of competence and of a high quality. Once this reputation has been established, a teacher automatically has more freedom to choose the levels and the schools he would like to teach and also to ask for certain privileges.
3. The stagnation of the teachers' training curriculum at all levels of the educational system and the nature of their courses' organization had distracted the teachers from teaching at these institutes.

In most cases the demanding students and the loads of work expected at these institutes were the main reasons of distractions.

Teachers mostly prefer teaching jobs. In some cases they accept administrative jobs such as being a headmaster, deputy headmaster etc., but they prefer to continue to practice in their subject (see details in Appendix 14, Table 14.11).

7.4.3.1 Biology teachers and the new biology curriculum and the textbook

The biology teachers expected that the new curriculum would be a breakthrough in the Iranian system of education. Some of them believed, upon observing the preliminary plan for the system of education, that the biology curriculum would be difficult and should have been taught at higher level in secondary schools. Their reasons for this attitude stemmed from the fact that in those days (1974) few universities could offer ecology in their curricula. The majority of the teachers had no previous background in this subject at all.

When the students' textbook was published the biology teachers were slightly disappointed because:

1. No teachers' guide or any sort of publication and resources were available for their studies.
2. The textbook was based on experimental work and they had to carry out fieldwork, read the references, answer the questions at the end of each chapter etc.

The above qualities and the volume of the book, the few hours (2 periods in a week) that were allocated to teach this amount of material also disappointed them further.

Interviews with the teachers at the in-service courses reflected their anxieties and difficulties with the new biology curriculum. In time, those teachers who continued to teach the new biology curriculum became interested in its teaching. Results obtained from the teachers' questionnaires showed that male teachers were more interested in teaching ecology than female teachers. Both groups of teachers believed that their students were not so interested in ecology as they themselves were (Appendix 14, Table 14.13).

When the results obtained from teachers rating the desirability or practicality of the curriculum goals were ranked, it was found that:

1. In the last three years of teaching the ecology syllabus their views towards these goals had changed. This is particularly explicit when we compare results obtained from the pilot study and the fieldwork from application of the same instrument. Also this author had made a note of teachers' attitudes and opinions about the curriculum goals in the first in-service courses in the summer of 1974, which can be used for comparison.

   Teachers had become more critical about these goals and realized that some affective goals in scientific attitude could be as important as the cognitive ones (Appendix 14, Table 14.15).

2. They believed that the gap between theory and practice is very wide for curriculum goals but narrows down for its specific objective, especially that of the status of man in the society.
3. It had been attempted to include these goals, particularly the scientific attitudes in the textbook, by including varieties of activities in the text.

   However, they did not believe that in the environment they teach the above goals could be implemented (see Appendix 14, pp. 527-531 for more details of the above discussion).

7.4.3.2 Teachers and their teaching situations

Teachers were teaching in crowded classrooms where they could hardly move. The only audio-visual apparatus was the blackboard on the front wall.

When they first started to teach this curriculum they received no help, except from the in-service courses in the summer. In these courses most of the emphasis was laid on the knowledge, experiments and teaching methods. The quality of these courses varied from one university to another. Teachers' general complaints were that the university lecturers were mostly unaware of the changes in the school curriculum and they were running their courses in the same old manner. However, most teachers found these courses satisfactory.

In their schools, they found that the headmaster was either reluctant to provide more equipment and materials or was restricted by space and bureaucracy in purchasing these requirements. Therefore the following difficulties persisted throughout the last four years (1974-1977):

(A) Lack of ~~the~~ laboratory and space to carry out experiments.

(B) Lack of materials and equipment.

(C) Lack of references and operational libraries.

(D) The existence of a large number of students in small classrooms.

(E) The attitude of officials to the usefulness of the fieldwork in teaching and learning.

They also found that the students have additional difficulties attributed to the curriculum materials. These are listed as follows according to their degree of importance attached by the teachers:

2. Understanding the textbook.

3. Applying their knowledge in a new situation.

1. Interrelating between chapters of the textbook.

4. Reading the text.

Some other difficulties were due to the culture and system of values in the society and school (see Appendix 14, pp.527-531 for more details).

All these factors were effective in the teaching method that the biology teachers could adopt for handling their school situations. The results obtained from the fieldwork study showed that teachers used varieties of teaching methods to teach the new biology curriculum. They were mostly finding that the volume of the textbook did not correspond with the weekly time (2 hours per week) that had been allocated for its teaching. On average they spent 15 weeks to finish the first section on ecology. The range of this figure (4 to 34 weeks) showed, depending on their teaching method, that they all found the available time insufficient. The declarations of all the past in-service courses prepared by the teachers also showed their persistent demands for increasing the teaching sessions for this syllabus.

As the results of the above problems, shortage of time, students' difficulties etc., teachers had to teach a shorter version of the curriculum which was well presented in the result of the achievement test. They had reached, with their students, a compromose about the amount of the materials to be taught and to be examined (Appendix 13, Table 13.31).

Few teachers who carried out the experiments viewed that some experiments were more practical in their schools and more useful to help students understand a difficult concept (Appendix 14, Table 14.18). They also managed to read few books, ranging in number between 2 and 9, on ecology.

7.5 Summary

The above discussion and those in Appendices 13, 14 and 15, show that the new biology curriculum mostly suffered, at its formative stage of development, from the following factors.

1. The political leader and his dissatisfaction with the progress of the technical education led to the change of the decision makers and top educational

elites that were well acquainted with the development of the new system of education. The consequent result was a period of no decision making and the maintenance of the status quo in the Iranian system of education.

2. The decision makers and the officials at the Ministry of Education were not briefed about the scope and requirements of the new system of education. The general information provided by the general director of the Curriculum Planning and Research Centre was not sufficient to emphasise their new roles for implementation of the new system of education nor was it sufficient to understand the details of the new curricula.

3. The sudden expansion of the system, abolition of private schools, and the introduction of new vocational, technical and comprehensive education proved too much for the poorly informed headmasters and the administ~~ers~~rators to guarantee their success. In many interviews with headmasters they were quite explicit on the above causes and still could not make head or tail of the new system.

4. Teachers were not consulted, nor their recommendations in their declarations considered for planning and reviewing the system of education. No provisions were made to publish a teachers' guide or to equip the existing laboratories and provide more books for students' reference in schools.

5. Several changes in the structure of the new secondary education (Chapters 2 and 6) disrupted the initial planning for the development of the system and preparation that had been made in advance. In the first two years many areas had no textbook, some received them a few months after the beginning of the academic year, and in many schools several editions of the same books were used. This condition, in addition to those of the students' and teachers' own difficulties, affected teachers' decisions on how to teach the new biology curriculum.

   As the result of the above factors the teachers and students had reached ~~to~~ a compromise on what to teach and what to learn. This conclusion was in line with those of official expectations.

It is therefore concluded that:

1. The new biology curriculum, compared with the old biology curriculum, was successful in introducing the science of ecology in school curricula and those of higher education institutes. Its text-book and the establishment of a laboratory mark, persuaded some of the reluctant teachers to read references and carry out experiments. The activities described in the chapters also indicate other changes and progress that had resulted from the implementation of the new biology curriculum in the Iranian system of education.

2. The curriculum was successful in creating new awareness, attitudes and expectations in the students and teachers. It also introduced an ideal for the textbook production. The ideal which was responsible for all the changes that were mentioned above.

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CHAPTER EIGHT

CONCLUSION AND SUGGESTIONS FOR FURTHER STUDY

The systems of education in developing countries are adapted from existing models in developed countries. Each system is then introduced into a variety of societies with different indigenous cultures, languages and socio-economic backgrounds. Since political elites in developing countries have different views on what aspects of developed society would be desirable, it is hoped that the new educational system will lead to the achievement of these goals. Recent studies show that the relationship between education and development is not a simple matter however. (1).

In a developing country, the most important factor influence on change in the educational system is the chief political leader and his views on the role of the educational system. He exercises his ideologies by manipulating a group of elites who occupy key positions in the country (see Chapter 7 pp. ١٨٧-١٨٩ for more details).

Another factor which will affect the educational system is the existence of a powerful indigenous ideology such as communism or a religious system of values, i.e. Islam. These factors, although facilitating the development of certain aspects of the system, oppose the adoption of foreign culture and a system of values.

On paper, the structure of a system of education in developing and developed countries are similar. In reality these systems differ in many ways. The developed country is characterized by having a high rate of literacy, numerous libraries, a wide variety of publications, openness to change, the existence of professional and amateur societies and institutes for research etc.

These conditions do not exist in developing countries that are still struggling with a high rate of illiteracy, lack of manpower, facilities, the existence of religious and political repression, lack of scientific research and development and pre-scientific modes of thought etc.

The similarities between these systems of education are in their structures not their functions. It is because of these reasons that the existing models of curriculum evaluation, employed in developed countries, provide an out of context statistical data and a misleading comparative interpretation of the data. (2).

8.1 Towards Development of a Curriculum Evaluation Model

Any model of curriculum evaluation is concerned with some aspects of the following:

1. The concepts and principles generated by research and development on previous curricula.
2. The study of the realities existing in the society and educational system.
3. The development of strategies and instruments that facilitate evaluation of curriculum effects.

Details of each of these three fields of enquiry are described below:

8.1.1 Concepts and Principles in Curriculum Evaluation

The research and development of numerous curricula have generated several concepts and principles. These concepts and principles can be summarized by questions shown on Fig.8.1

A close study of these questions reveals that they are all related to one another. However, various models of curriculum evaluation include some of these questions with differing emphasis. The cause of this variation is in the historical development of the model and the nature of the curriculum that it has been designed to evaluate.

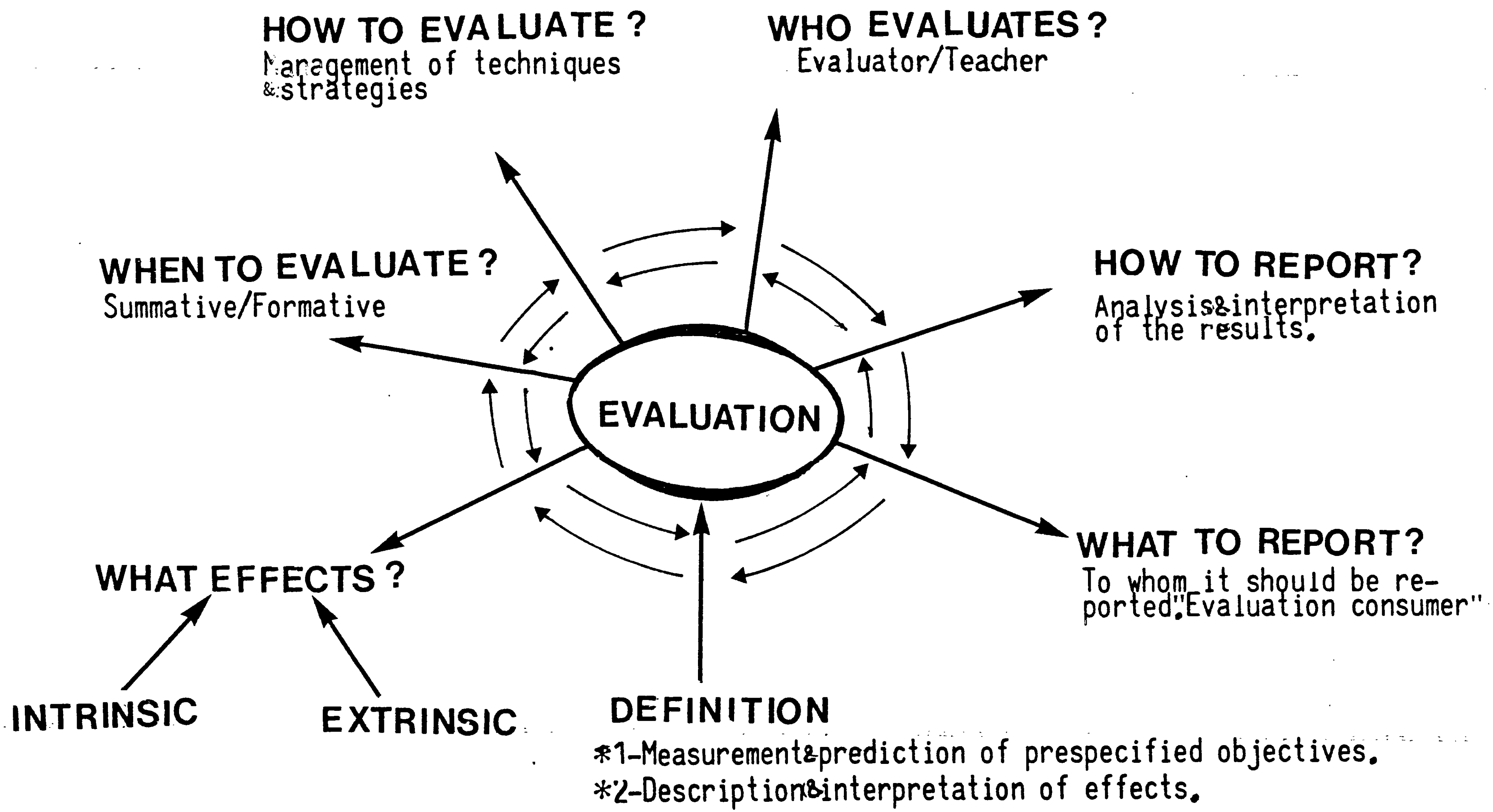
There are several general models for curriculum evaluation which have different goals and apply different strategies to evaluate the effect of an innovation. Depending on which model one uses the answer to questions in Fig. 8.1 vary.

I. In the goal-attainment group of models for curriculum evaluation, it is assumed that a set of pre-specified objectives of the curriculum effects exist. The role of the curriculum, therefore, is to measure and predict the attainment of these pre-specified objectives.

In answering the question "what effect should be evaluated", the goal-attainment model for curriculum evaluation suggests intrinsic and extrinsic criteria. By intrinsic criteria the merits of the curriculum itself is evaluated. The extrinsic criteria refer to the effects of the society, schools, teachers and students on the curriculum objectives (see Chapter 5 for further discussion of this subject).

The timing is crucial in planning an evaluation study. If the curriculum understudy is in its trial stage then formative evaluation of its effects provide data for course improvement. The curriculum on the market can be evaluated

Figure 8.1: Some pertinent questions in curriculum evaluation programme. Evaluation programme can be started by answering any of these questions and continuing the process around the circle.



by summative evaluation which gives an indication of the effectiveness of the innovation. In both cases the pre-specified objectives are the most important criteria for the judgement of the merit of the curriculum.

It is possible to employ continuous or formative evaluation on the implemented curriculum to obtain data on its effectiveness and course improvement.

The goal attainment model employs experimental designs for evaluation, similar to those used in psychological research. In this strategy the selection of a random sample of the population, a control group and true experimental design are of great importance.

The question of the choice of instruments and techniques, and the management of the curriculum evaluation depends on the nature of the materials under study. It also depends on the time, cost and the type of the consumer that the study is provided for.

The evaluator in developed countries has been, traditionally, an educationalist or an expert in educational psychology or measurement. He had academic status and the professional educational background. In time the upgrading of teachers' education gave them sufficient qualifications to conduct an evaluation study. Hence the evaluator became either a member of the academic and professional educators or the class teacher. This latter case condition does not exist in developing countries.

No matter who evaluates the curriculum innovation, he must prepare his report for a particular audience. The customer of the curriculum evaluation varies in different countries. In the United States the existence of state funds for educational research has made the curriculum evaluator accountable towards a committee or a local educational authority. In England, it may be the Schools Council or another research centre who employs an evaluator. The difference between the two systems is that in the latter system the evaluator is always an academic and professional person. In the United States he may be a teacher or any qualified person.

There are several kinds of information required by several types of customers, from an evaluative study. This affects the analysis of the results and the way the report should be made:

(A) The curriculum evaluation may be concerned with judgement of the merits of innovation. These data may be required for adoption of the innovation on a larger scale.

(B) In individualized learning, the diagnosis of what students know and what they do not know is crucial for remedial treatment and instruction of the students.

(C) In the absence of any models for measurement and assessment of the qualities of the innovation a technology of curriculum measurement may be required.

(D) In some cases comparative studies between instructions, curricula and individuals are required for various kinds of decision making such as students' placements.

All of these categories require different decision makings of the curriculum management, strategy and the choice of the evaluation instruments. For example we may decide to adopt a Norm-referenced test for category D or a Criterion-referenced test for categories A and B.

II. <u>In the illuminative model of evaluation</u> the main objective is to describe and interpret the process of the development of the innovation. In this procedure a variety of aspects are studied to provide a comprehensive interpretation of the teaching and learning "milieu" for decision making about certain curriculum merits.

The choice of using an illuminative evaluation strategy leads to different answers from the questions shown in Fig. 8.1. The fact that illuminative evaluation is not based on pre-specified objectives provides a better interpretation of the intrinsic evaluation study than the goal-attainment model. The results could be compared with pre-specified objectives, where they exist, to confirm or reject their attainments (see goal-free evaluation on pp.96-97).

The illuminative evaluation also provides a wider scope of enquiry on various aspects of the extrinsic criteria. It includes study of the interaction that exists between elements in the curriculum materials and those of the extrinsic criteria.

However, it is assumed that an evaluator should be an educational elite who provides his own interpretation and description of the results. He prepares his report for academic audience and educational managers who make decisions on certain aspects of the curriculum innovation.

III. Interactive model of evaluation can be developed by the combination of different aspects of the above two general models. Concepts and principles, strategies and instruments from both evaluation models are combined to provide comprehensive data on the cause and effects of the development of the curriculum innovation. This model is the subject of the present chapter and will be discussed in later pages.

8.1.2 The Realities that exist in the Developing Countries

The differences between educational systems in the developing and developed countries are generally not due to the structure of the systems of education. Their differences should be sought in the functions of their system and the interaction between various elements in the society with that system. The elements which are characteristic of the developing countries and are not found in developed countries:

(A) The political leader and his ideology. In most of these countries the political leader is a totalitarian figure and controls the whole system. He manipulates a group of elites to disseminate his ideologies in various sections of the system.

(B) In the centralized systems of education a central body is responsible for curriculum development. A unified language is used for learning and instruction. A unified textbook is taught throughout the country. The indigeneous languages and cultures are purposely ignored to create a unified nation.

The development of a unified nation with such characteristics facilitates dissemination of political ideology, the planning and financing development plans and provides a stronger basis for manipulating the masses.

(C) Cultural and religious factors. In many developing countries, especially the Muslim countries, the existence of Islamic culture and religion is the most effective factor in restricting development. Islamic systems of values contribute to every aspect of a man, society and knowledge. They oppose innovations and discourage changes. The most quantitative effect of Islam is the creation of pre-scientific systems of thought which is described in various research studies on the attitude of students in these countries. (3).

(D) Socio-political and economic environment. The developing countries either have a strong Islamic culture or other religious ideology or a political system of values which function in the same way. In most cases the political and religious repressions are indigenous characteristics of the system which is manifested by the following outcomes: The number of publications are very few. There are little or no research and development institutes. The educational facilities and resources are very poor.

Different cultural expectations from the teacher restrict his normal functions.

Government propaganda and its use of media is biased for its own benefit and dissemination of the rulers' ideology.

Educational opportunities, due to the lack of manpower or economic resources, are limited.

There is a high rate of illiteracy.

The study of these factors is crucial in interpreting the results obtained from achievement tests or teachers' questionnaires. They provide validity for statistical results of the experimental instruments. For example, several test items that were found difficult in all schools could be attributed to the effect of change in the book edition. The reason why teachers had not recommended references in Iran was that political environment discouraged: (a) inquiring minds; and (b) publication of books and various materials.

IV. The development of strategies and instruments. The development of a model for curriculum evaluation should not be based on the structure of the system of education but on the realities that exist in that system. In developing countries, although the use of experimental models of evaluation may provide statistically significant data, their interpretations require additional data about the system. Therefore it is necessary to use the combination of illuminative and experimental strategies in order to provide concurrent data about the results of the instruments.

The choice of instruments depends on the pilot study and the knowledge acquired from the system. The evaluator must be an indigenous educationalist who not only has knowledge about educational research and development, but also one who easily spots the problematic areas. His local knowledge about that system, teachers and students, is vital when instruments for the research study are developed.

In the Iranian system of education it was noted how teachers were reluctant to permit interviews to be recorded. Therefore, once rapport was established, comprehensive notes about the interview were made afterwards.

8.2 The Interactive Model for Curriculum Evaluation

The interactive model of curriculum evaluation is the result of study on the new biology curriculum implemented into the Iranian system of education. This model has the following characteristics.

(A) The model was developed as the result of a literature survey and proposition of several questions about pertinent aspects of the curriculum evaluation. It is basically a summative model since the biology text was already on the market.
The objective of the model is to evaluate the effectiveness of certain criteria about the curriculum innovation. It is projected that a follow-up study should be developed to facilitate a formative evaluation of the curriculum materials for improving the quality of the students' textbook.
The model is called interactive since it describes the interactions between various factors affecting curriculum effects.

(B) The fact that the biology curriculum had no set of pre-specified objectives provided a condition of goal-free evaluation. In the intrinsic evaluation the curriculum analysis and goal analysis were used to provide a variety of information about the merits of the curriculum. In this process details of the students' textbook were analysed and then translated into behavioural objectives. This list was compared with the list of objectives obtained from the analysis of the curriculum goal.

These procedures have to be of great importance for evaluating any curriculum in developing countries. Curriculum and goal analysis provide comprehensive data about the content of the curriculum materials. Such data is useful for training teachers in developing countries where teachers are mostly unfamiliar with their jobs. The Iranian example showed some of the reasons why teachers taught selective objectives were thought to be due to their unfamiliarity with the curriculum, lack of background knowledge, and the inefficiency of the in-service courses in preparing them for teaching their materials etc.

The use of curriculum analysis and goal analysis in teachers' training, especially in-service courses, will improve teachers' knowledge on background knowledge and the curriculum.

In addition information is provided for judging the merits of the curriculum material. An objective basis is also available for the development of the assessment instruments.

(C) The model emphasises the comprehensive study of various aspects of the system of education in order to distinguish problematic areas and provide information about schools, teachers and students. Figure 8.2 summarizes details of the above model.

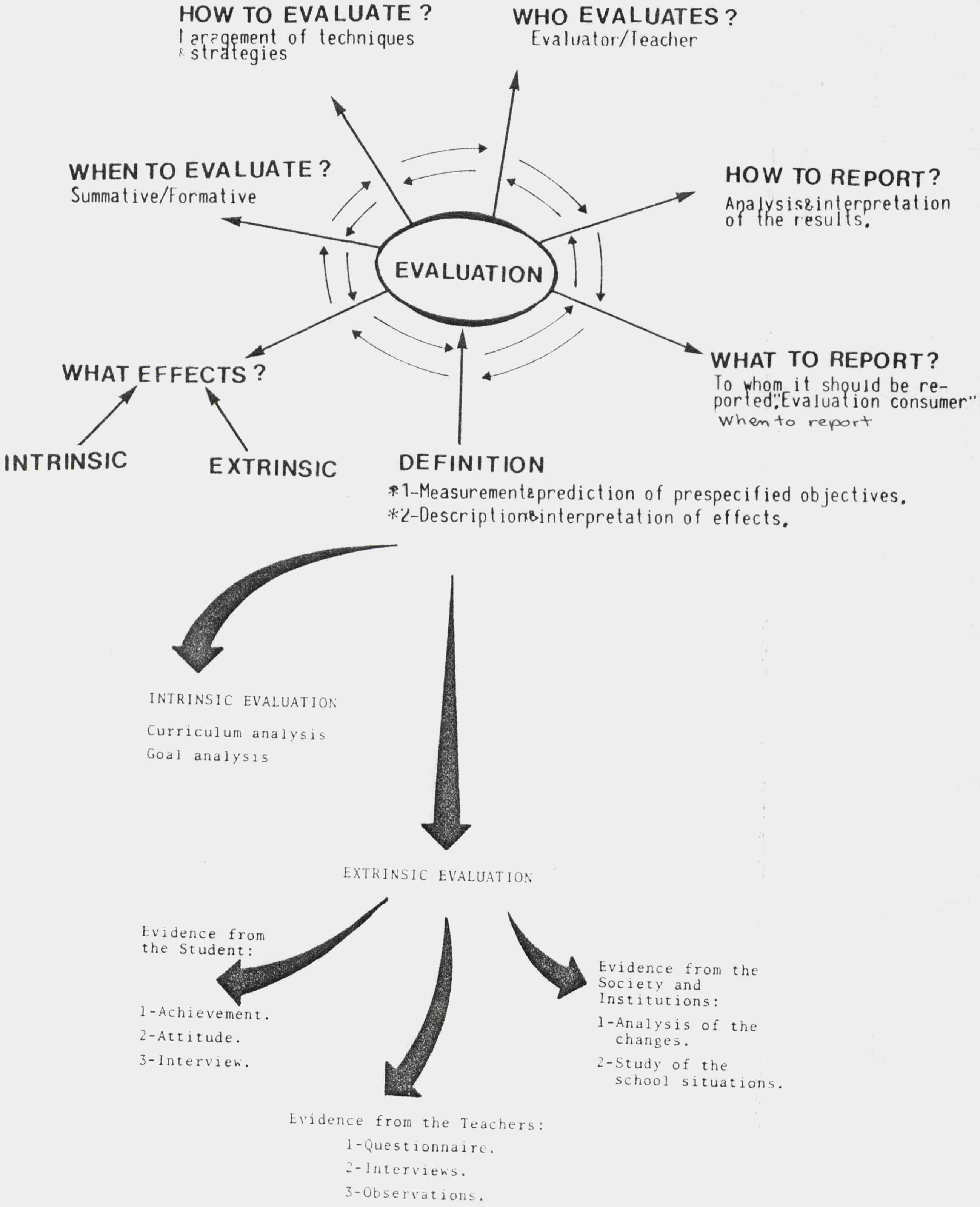
(D) The instruments used in the model were developed in two stages: (i) the pilot study stage; and (ii) the fieldwork or experimental stage.

The achievement test was a criterion-referenced test (CRT) which was developed to compare instructions in the schools and provide data about students' achievements. The success of the use of CRT in this case showed that it could provide a technology for the teacher and the educational evaluation where no such technology previously existed. The choice of criterion-referenced test originated because:

(a) In the Iranian system of education teachers mark students' examination papers in terms of the number of questions they have answered correctly. Students should gain a mastery above the 60 percent cut-off score to pass the subject.

(b) The criterion-referenced test is more meaningful for the teacher if he wants to know what

Figure 8.2: A summary of the interactive model for curriculum evaluation. The procedure of curriculum evaluation starts by answering the following question about the curriculum in question. Then selected intrinsic and extrinsic criteria are evaluated by the application of both experimental and illuminative evaluation strategies in pilot and fieldwork stages.



his students know and what they do not know. This condition could help him to guide his students for mastery learning of the materials.

(c) The biology curriculum is examined by the subject teacher and there is no value in comparing students' scores with those of the population of students.

(D) The evaluation report should be comprehensive. It should pin-point deficiencies and merits of the system and the innovation. It should also provide the solution for those deficiencies which severely affect the attainment of curriculum objectives. The report should be written in two forms. A professional report should provide technical information for research and academic personnel to make them acquainted with the model. The other, digested, version should address teachers and those interested bodies at various departments of the government to provide them with a non technical data for educational planning and decision making. The implication of the first report is to introduce a model for evaluation that could be duplicated by the research students at the higher education. The second report provides more understanding of the system of education to bureaucrats at the Ministry of Education.

It is sometimes customary to lay the blame for any deficiencies of the system on teachers. Teachers also accuse students for not being interested. The evaluation of the biology curriculum seemed to show that the inefficiencies in the system are not totally contributed by the students and teachers. The decision makers and the educational administrators are also at fault in not understanding the nature of innovation and providing facilities for its successful implementation.

It is hoped that gradually the increasing number of evaluation studies will encourage objective judgement about development and effects. Various aspects of the system of education consequently prevent uniformed decision making by the administrators. An understanding of the process of educational development might create a better attitude towards the role of education.

Reports written on the use of this model of evaluation may be used by students, teachers and administrators, research students, or professional educational experts.

8.3 Projection for Future Research Study

The model of curriculum evaluation was successful in providing comprehensive data on the development of the biology curriculum. This model provided a summative evaluation of the curriculum effects. It is suggested that investigations should be carried out in the following areas:

1. Future studies should emphasise the continuous or formative evaluation of students' achievements. The present achievement test provides general

information on the attainment of selective concepts and principles randomly chosen from the curriculum domains. It is not, however, clear if the attainment of these concepts had been due to the mastery of the background knowledge of students, or information they received from teachers' instruction, or from the textbook. The results show the overall effect or ineffectiveness of these factors. The second suggestion for the improvement of the achievement test is to develop test items on all the domains existing in the goal analysis. Then a formative evaluation of the several summative assessments should provide a distinction between the effect of the teacher and the textbook. It should also provide insight into the effects of the various parts of the textbook on the attainment of each domain. A collection of data could provide a basis for course improvement.

2. The teachers' questionnaires can be further improved for flaws in its questions. Several areas in this questionnaire, i.e. in-service courses, need to be expanded and fully investigated. Teachers' attitudes on ecology could be elaborated to provide more data about the nature of their attitudes. In the same way the students' attitudes can be evaluated by the existing scales developed by other researchers.

On the whole, the existence of instruments for experimental studies provides more time to investigate other areas. Some of these areas in the study could include student-teacher relationships in the Iranian system of education, teachers' methods of instruction, evaluation of the effect of experimental activities on student learning and development of an attitude towards ecology etc.

8.4 Summary

The interactive model for curriculum evaluation was developed to evaluate the new biology curriculum in the Iranian system of education. The model has a wider application for other subjects and in other countries with the same general characteristics described for the development of the model.

The model was based on the assumption that differences between developing and developed countries lay not in the structure of their systems of education but in their functions. During the development of the model of curriculum evaluation, elements from society, the educational system and the cultural and religious systems were shown to be effective on the results obtained from the model. The model had the following characteristics:

1. It was basically founded on literature reviews, analysis of the characteristics of the developing countries, and decisions on the strategies and choice of instruments.
2. It was a summative evaluation of the effectiveness of the curriculum innovation and operated in two

stages: (i) pilot study; and (ii) the fieldwork.

3. It employed intrinsic and extrinsic evaluation for studying evidence from the curriculum, society, educational system, teachers and students.
4. It provided technology for research and assessment for teachers and evaluators and provided instruments that could be used for evaluative purposes.
5. It requires an indigenous evaluator and should lead to two types of reports: (i) a technical and professional report for academic; and (ii) a simplified report for bureaucrats at the various departments of the Ministry of Education. The aim of this report is to create an objective basis for judgement about the system of education as a whole. This process prevents hasty decision making about the role and function of the system of education.

Finally, it has been suggested that future studies should be concerned with expansion and improvement of the existing instruments. The existing instruments provide opportunities to study other aspects of the system. It is not necessary to spend further time on the development of new instruments.

References and Notes on Chapter Eight

1. MAYBURY, Robert H. (1975). Technical assistance and innovation in science education. *Science Education* and interscience publication. New York: John Wiley & Sons. p.183.

2. This comment refers to the results of the comparative study of cognitive achievement in science and mathematics reported in International Studies in Evaluation publications. In: Peaker, F. Gilbert (1976). An empirical study of education in twenty-one countries: a technical report. p.36. International Studies in Evaluation VIII. Stockholm: Almquist and Wiksell International. No details of the samples used in Iran was given. This study was based on the structure of the system of education in twenty-one countries and vigorous statistical procedures were used to analyse the results.

3. MAYBURY, Robert H. (1975). *Op. cit.* p.184.

APPENDIX 1

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G. Details of The Experimental Science Syllabuses

(p.p.118-121)(1)

Introduction:

The youths who finish Secondary Education have reached a physical and mental development stage where they can expect to benefit from their previous achievements. This happens in one of two ways: either by studying at a University; or by entering the labour force and establishing independent life. Hence the main axis of Theoretical Secondary Education should be chosen in such a way to realise this logical expectation of youths, that is, to prepare them for entrance to society and University.

Experimental Sciences, obviously, have an effective and noticeable function in this preparation and as a whole in fulfilment of the principal aim of education, "preparation of individuals for a better life".

In the preparation of the details of the experimental Science syllabuses at the Theoretical Secondary Cycle, in addition to those above, the following points were also considered:-

1. The Experimental Science syllabuses in primary education and the three years of the guidance cycle were studied carefully. The opinions and evaluation results of these were also considered.

2. At this cycle in accordance with the physical and mental development of the pupil, separate courses in Physics, Chemistry and Natural Sciences were included, and a special syllabus was developed for each so that there would be provided more and better opportunities for analysis and synthesis of similar subjects taught previously at

the guidance cycle.

3. The designed syllabus covers, as much as it can, details of different topics. Their limits and extents are also indicated.

4. No special model was followed for designing this syllabus but curricula and textbooks from various progressive countries were examined and studied. After the principles had been compared with the environmental resources and circumstances according to the present and future needs of this country, this curriculum was planned and developed.

5. In designing the syllabuses, in addition to the experts from the Curriculum Planning and Research Centre, a group of knowledgeable university professors, experienced teachers and representatives of the Science Teachers Association gave continuous co-operation.

General Goals

1. Development of Scientific Attitude:

(1-1) Observation and realization of the existence of problems in experimental sciences.

(1-2) Collection of relevant data and information for the discussed problems.

(1-3) Providing temporary hypothesis for describing and interpreting the problems (to design experiments, to carry out experiments, to suggest a temporary model or hypothesis).

(1-4) Interpretation and logical description of the data obtained and reluctance to accept results without sufficient confirmatory evidence.

(1-5) Generalization of the obtained hypothesis and its utilization in predicting and interpreting more general concepts and phenomena.

2. Development of interests in solving daily problems and difficulties by scientific approach.

3. Development of the ability and interest in pupils to fulfil some of their personal and family needs, from the point of using new tools and equipment, related to experimental sciences.

4. Acquisition of minimum knowledge by the pupils who will be exposed to different subjects of the Theoretical studies.

5. To develop skills in using laboratory apparatus and following safety rules in carrying out experiments.

6. Familiarization of the pupils with scientific terms that they may encounter in daily life.

<u>Instructional Methods</u>

To fulfil the above goals, the application of the following methods seems to be beneficial:-

1. This curriculum is based on observation and experimentation. Therefore science teachers should give preference to experimentation over lecturing, and deduce the concepts of each lesson by experimentation.

2. It has been attempted, as much as possible, to keep suggested experiments simple and clear so that pupils could perform them personally and obtain the results, therefore the science teachers will try grouping pupils in order that they can carry out the experiments.

3. The inclusion of tables and historical evidence in the syllabus could facilitate the understanding of scientific concepts and develop interest in studying scientific problems, therefore pupils should not be expected to memorize these.

4. To fulfil the main goal, No.1. that is: "Development of Scientific Attitude", science teachers should avoid a lecturing method in teaching as much as they can and, by carrying out experiments and indicating examples and evidence, try to persuade students to rediscover scientific concepts and principles (Discovery method).

5. The use of scientific trips and visits to factories is an effective method of creating interests and understanding scientific concepts. Therefore science teachers should, as much as they can, make use of this useful method and persuade pupils to make a report of what they have seen.

6. Attention to graphs and persuasion of pupils to make various graphs in each of the three sections of experimental sciences is very necessary and useful.

7. Obviously science teachers should not limit themselves to performing only the experiments in the programme to exercise better teaching, but should include any other experiments they think are essential and useful. When possible, they should also guide pupils to perform them.

8. Laboratory activities of pupils should be helpful in the evaluation of their progress of their study.

9. In the operational procedure, pupils should be encouraged and guided to make certain laboratory tools and equipment and collect specimens of insects, rocks etc. These activities are useful in the progress of the syllabus and the fulfilment of the goals.

Section Three - Biology and Geology (p.p.144-146)(1)

Specific goals:

In the Biology syllabus, in addition to the general goals the following specific goals are also considered:-

1. Understanding similarities and diversities amongst organisms in nature.

2. Understanding the status of man in the living world. That he is a living organism with similar function and has close relationship with other organisms on the earth.

Instructional Methods:

1. At the end of the Biology programme, a list of experiments that should be carried out in each relevant chapter has been included, which facilitates the preparation of the list of the chemicals and equipments needed for the experiments.

Obviously, Biology and Geology teachers will do the set of experiments relevant to their chapter.

2. The curriculum developers believed in deducing a principle by discussion of its constituent components. This method has been implemented in the whole curriculum development. Obviously, the teacher will follow suit in their teaching.

Biology Syllabus - First year (2 hours per week, 64 hours in an academic year)

Introduction:

What is Biology?

Definition of living things - similarities and differences between living and non-living things.

Nutrition:

1. Introduction (the importance of nutrition in terms

of the need of living organisms to matter and energy).

2. The need of organism for matter:

(2-1) Autotrophism and its different degrees, in summary.

(2-2) Heterotrophism and its different degrees, in summary (Herbivority, Carnivorousness, Omnivorousness, Saprophytism, Mutualism, Parasitism and Commensalism). The pyramid of matter.

3. The needs of organism for energy:

(3-1) Sources of energy (light and chemical energy). The pyramid of energy.

(3-2) Methods of using energy (Photosynthesis - Chemosynthesis).

(A) Photosynthesis: Mechanism of photosynthesis - Structure of leaf and chloroplasts - photosynthetic products - The effect of carboniferous fertilizers (any materials that liberate CO_2 on the output of photosynthesis.

(B) Chemosynthesis - Mechanism of Chemosyntheses - comparison of photosynthesis and chemosynthesis.

Living Communities:

1. Individuals and populations - Introducing two representatives of animal communities (Honey bees and ants).

2. Population density - Factors affecting population density - population equilibrium.

3. Change in population due to biotic and abiotic factors.

4. Interaction amongst populations:

   (4-1) Food webs and food chains.

   (4-2) Competition amongst organisms.

   (4-3) Population succession.

   (4-4) Community boundaries (populations interactions).

5. Adaptation (from the point of survival).

6. Diversity of ecosystems:

   (6-1) Aquatic ecosystems.

   (A) Marine (in summary).

   (B) Freshwater (river, lake).

   (6-2) Terrestrial ecosystem:

   (A) Forest.

   (B) Mountain.

   (C) Grassland.

   (D) Desert.

   Pollution and the preservation of each ecosystem should be indicated.

7. Discussion about human population and its effects on other communities of living things.

<u>Experiments related to different Biology Chapters</u>

(p.p.154-155)(1)

Chemical structure of living organisms:

Testing Lipids:

1. Insolubility in water, solubility in lipid solvents.

2. Preparing a sample of emulsion and comparing it with a natural emulsion (milk).

3. Testing lipids, in an oil seed, with Sudan III.

Testing Carbohydrates:

1. The effect of saliva on the hydrolysis of the starch grain.
2. The effect of dried barley germ extract on the hydrolysis of the starch grain and observation of its chemical change with the help of potassium iodide (Lugol's solution).

Testing Protein:

1. Protein coagulation (in meat or egg white) as the result of heating.
2. Biuret reaction.
3. Pepsin and protein digestion.

Studying Cells:

1. The Microscope and how to use it.
2. Study of onion skin - staining with a solution made of equal amounts of Methylene blue and Neutral red.
3. Study of the cheek cells - staining with Lugol's or Methylene blue solution.
4. Study of a drop of pond water (variation of animal and plant cells).
5. Study of the mitotic stage in the onion root tip cells - staining with aceto-carmine.

Nutrition:

Photosynthesis

1. Demonstrating photosynthesis in Geranium, or any other green, leaf with the help of Sodium Bicarbonate - indicator.
2. Studying Chloroplast in the Spring onion leaves.
3. Extracting Chloroplast pigments and their separation from each other by the help of paper chromatography.

4. Testing starch formation in leaf - studying different types of starch grains in different plants (Maize, Bean, Potatoe and Wheat).

Living Communities

1. Adaptation of plants to environment and the effect of this adaptation on the structure of leaf.

   (1-1) Observation of different environments (Arid, marsh, freshwater and salt-water). Studying spine, hair, epidermic thickness and leaf thickness.

   (1-2) Studying stomatal distribution on leaves (in the section of the Nerium leaf and in longitudinal and vertical section of other leaves).

2. Air pollution: The effect of air pollution on plant leaves, observation of leaf appearance and its trace on a white filter paper.

3. Studying intra-species competition (e.g. two clover species with other plants).

4. Making an aquarium to study interaction amongst organisms.

5. Making fumarium to study a sample of animal community.

1 - Ministry of Education (1970). *Details of the Curricula for the first years of Theoretical Study.* New System of Education. Publication No.6. Tehran: Centre for Research and Curriculum Planning (in Forsi).

APPENDIX 2

Defining the Curricular and the Textbook behavioural objectives

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A. Defining the Curricular goals into behavioural objectives:

Introduction:

In 1965, Lewis summarized the most important models developed to formulate objectives of teaching science, of which *Bloom's Taxonomy of Educational Objectives* is now the most popular in research and evaluation of science education (1).

The taxonomy includes three distinctive domains: (1) Cognitive domain, (2) Affective domain and, (3) Psychomotor domain. Each domain has major categories and subcategories.

The cognitive domain, for example, has six major categories that have been arranged in a logical hierarchy, the later ones depending to some extent on the earlier (2).

6. Evaluation.
5. Synthesis.
4. Analysis.
3. Application.
2. Comprehension.
1. Knowledge.

The same pattern applies to the "Affective domain" (3). The psychomotor domain is still in preparation but a simple version of the main categories is available elsewhere (4).

The Bloom *Taxonomy of Educational Objectives* is based on the behaviourist theory of learning, that the outputs of learning are observable and describable. Therefore we can set up objectives to evaluate the performed behaviours (5).

There are two main critics of this taxonomy:

1. The hierarchy of categories within each domain tends to suggest that more complex abilities should be

identified in terms of their components. Therefore, according to Eggleston (1968), it "may fail to sharpen our perceptions of patterns which help us to identify the more complex behaviours" (6).

2. The over-emphasis on the distinction of Cognitive-Affective, Affective-psychomotor and Cognitive-psychomotor may suggest that no overlapping exists between these domains. Whereas it has been shown that at least certain levels of affective domain correspond with objectives in Cognitive domain (7) and in laboratory activities in science distribution between these three domains are not always easy.

In spite of these criticisms and those related to the question of the behavioural objectives (8)(9)(10)(11)(12), the Bloom's taxonomy has proved useful in the following ways:-

a) In facilitating the construction of a test instrument which makes a wider, if not comprehensive, range of demands on pupils.

b) In classifying objectives and serving as a check-list for comparison with independently prepared lists.

c) In enquiring into the nature of the relationship between pupil behaviours defined in terms of the taxonomic categories.

d) In determining the range of demands made by new materials produced in curriculum development.

(Eggleston, 1968)(13)

It was due to these criteria that the taxonomy has been used intensively during the last two decades. Many modified versions were developed, as a result of research and evaluation of new curricula, especially in the field of science. For example Klopfer (1971) (14) developed a comprehensive modified taxonomy for objectives of science education on the basis of Bloom's taxonomy and the B.S.C.S. project, which did not accept the behavioural objectives for its first stage of curriculum development (15), prepared a list of behavioural objectives to evaluate the test items (16).

These two models have introduced two types of improvements to avoid the recent criticism stemming from the application of Bloom's Taxonomy in science:-

1. A separate interdisciplinary list of objectives was provided for the scientific inquiry activities (mostly covers the laboratory and experimental activities).

2. The "Knowledge" and "Comprehension" in Bloom's Taxonomy, which mostly overlap in the actual evaluation situations (17)(18) were considered under the same title: "Knowledge and Comprehension" to make the evaluation more realistic.

However, in 1964, Goodlad noticed that there exists "striking similarity in the aims and objectives of nearly all (New Curriculum) projects" (19), which still applies to the present projects and curricula.

A careful analysis of the "general goals of the science syllabuses" (Appendix 1) justifies Goodlad's comments. These goals emphasise four following areas:-

1. Development of scientific attitude (science inquiry).
2. Acquisition of the basic knowledge of terminology.
3. Application of this knowledge and scientific attitude and manual skills in the immediate environment and future study.
4. Development of interests and positive attitude towards science.

The above areas are identical to the B.S.C.S. major kinds of abilities (20) and the major aims of any other science curricula.

Defining the curricular objectives:

Since it was necessary to compare curricular goals and objectives with those of the content and test, they were translated first into behavioural objectives to provide a similar comparable basis for the study. The following steps summarize the procedures above:-

1. The general goals were analysed and interpreted using Bloom's Taxonomy of Educational Objectives and a behavioural translation of the goals was developed. Some references proved to be useful at this stage: Gronlund (1970) (21) for the instructions to state behavioural objectives, Klopfer (1973) (22) for the list of science teaching objectives and Klinchmann (1963) (23) for the B.S.C.S. test grid.

2. The same procedure was used for the objectives in the instructional methods.

3. The details of the syllabus were used as a yardstick to interpret the level of abilities expected.

4. The preliminary list of objectives prepared were checked and rechecked against the original Persian version and the English translation of this version. A final revision was completed by repeating steps 1 to 4 above.

In the list below each objective corresponds with its most appropriate original goal.

The behavioural version of the Curriculum goals

I. Cognitive Domain

1.0 (Knowledge).

1.1 Knowledge of scientific terminology (goal No.6).

1.2 Knowledge of specific facts (goal No.4).

1.3 Knowledge of trends and sequences (goal No.4).

1.4 Knowledge of scientific techniques and procedures (goals No.1, 3 and 5).

1.5 Knowledge of scientific principles and laws (goals No.3, 4 and 5).

1.6 Knowledge of theories and major conceptual schemes (goals No.2, 4 and 6).

2.0 (Comprehension).

2.1 Translation (goal No.6 and instructional goals No.5 and 6).

2.2 Interpretation (goal No.1, 4 and instructional goals No.3, 4 and 5).

2.3 Extrapolation (goal No.1, instructional goal No.4).

3.0 (Application).

3.1 Application to new problems in the same field of science (goal No.4 and details of the syllabus).

4.0 Other higher abilities (Analysis, Synthesis and Evaluation).

II. Development of Scientific Attitude

1.0 Observation of objects and phenomena (goal No.1-1).

2.0 Description of observation using appropriate language (goal No.1-1).

3.0 Selection of appropriate measuring instruments (goal No.3-1).

4.0 Recognition of problem (goal No.1-1).

5.0 Formulation of a working hypothesis (goal No.3-1).

6.0 Selection of suitable tests of a hypothesis (goal No.3-1).

7.0 Design of appropriate procedures for performing experiment (goal No.3-1).

8.0 Processing of experimental data (goal No.3-1).

9.0 Interpretation of experimental data and observation (goal 3-1).

10.0 Extrapolation and interpolation (goal No.5-1).

11.0 Evaluation of hypothesis under test in the light of data obtained (goal No.4-1 and 5-1).

12.0 Deduction of new hypothesis from the hypothetical mode (goal No.5-1).

III <u>Affective Domain</u>

1.0 Scientific attitude (goal No.1 and instructional goal No.4) includes:-

1.1 Responding 1.2 Valuing 1.3 Organization (Krathwohl, 1971, p.37)

2.0 Interests (goal No.2 and 3; instructional goals No.3, 5 and 9) includes:-

2.1 Receiving 2.2 Responding 2.3 Valuing

IV <u>Psychomotor Domain</u>

1.0 Development of skills in using basic laboratory equipment (goal No.5; instructional goals No. 4 and 7).

2.0 Performance of basic laboratory techniques with care and safety (goal No.5).

The above list roughly summarizes details of the objectives indicated in the general goals.

In the following some aspects of the list have been discussed further:-

1. The category I. 4.0 implies that no direct indication was made to these abilities in the goals (except

for the goal 1). But, the details of goal 1 justify their inclusion.

2. The objectives described in goal 1: The Development of Scientific Attitude showed similarities to those attaining to "The Process of Scientific Enquiry", but they were not set out in a straightforward order and were ambiguous. Therefore, it was decided to rearrange the objectives in a more logical and comprehensible sequence.

3. The inclusion of attitude in the affective domain was to emphasise those specific attitudes, e.g. attitude toward Biology, that are indicated in goals.

This distinction between general and specific has implication in evaluation design.

4. The distinction between Knowledge and Comprehension was not always an easy task. The result from content analysis and content specific objectives also indicates how much overlap is possible between these two objectives. Some authors have already indicated such a deficiency of Bloom's Taxonomy (24). One author has even considered them, in the same category, in his list of objectives for science teaching (25).

However, in spite of the overlap between these two objectives, it was decided to keep them separate in order to facilitate the comparison between curriculum and textbook objectives.

B. Defining the textbook behavioural objectives:

In the absence of any set of objectives for the textbook one may assume that all or some of the curricular objectives have been reflected in the textbook. The goal analysis should provide evidence for this hypothesis.

The following analytical steps were followed to interpret and define the textbook behavioural objectives.

1. Evidence from the content analysis showed what types of activities are involved in each chapter.

2. In deciding the level of general objectives for each chapter, the most important criteria used was what students learn from the text (26).

3. Once the level of general objectives had been decided, they were defined into behavioural objectives by the use of the key words suggested by Metfessel, N.S. *et al.* (1970) (27) and Gronlund (1970) (28). Then the list was checked for the accuracy of the above criteria, against the check-list in Gronlund's "stating behavioural objectives for classroom instruction" (29).

4. The general objectives were then translated into specific behavioural objectives, using the details of the content analysis (in English) and the textbook (in Farsi) as the yardstick.

5. Following procedure No.4, the general objectives were further revised.

6. Once the general and specific objectives were defined and the content outlined, a table of specification was prepared (Table 1).

Table 1

Content \ Outcome	Cognitive						Affective					Psychomotor	
	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Receiving	Responding	Valuing	Organization	Characterization	Developing skills in using equipment	Performance of techniques with safety
The web of life	X						X	X	X				
Autrotrophism	X	X	X	X	X		X	X	X	X	X	X	X
Heterotrophism	X	X					X	X	X			X	X
Ecosystem: Structure	X	X					X	X	X	X	X	X	X
Ecosystem: Function	X	X	X				X	X	X				
Population	X	X					X	X	X	X		X	X
Interaction	X	X					X	X	X				
Ecosystems: Aquatics	X	X					X	X	X				
Ecosystems: Terrestrials	X	X					X	X	X				

The following pages provide the details of the general and specific objectives of each chapter of the book:

Details of each chapter behavioural objectives

Introduction: The Web of Life

General Objectives

Cognitive Domain

1.0 To know the variety of food sources.

2.0 To know about producers.

3.0 To know about consumers.

4.0 To know about decomposers.

5.0 To know about Autotrophism.

6.0 To know about Heterotrophism.

7.0 To know the definition of Ecology.

Specific objectives

1.0 To know the variety of food sources.

1.1 To define food as organic materials.

1.2 To name a variety of foods.

2.0 To know about producers.

2.1 To define the term "producer".

2.2 To name a variety of producers.

2.3 To describe the producing process.

3.0 To know about consumers.

3.1 To define the term "consumer".

3.2 To name the varieties of consumers.

4.0 To know about decomposer.

4.1 To describe decomposers.

4.2 To name some decomposers.

5.0 To know about Autotrophism.

5.1 To define Autotrophism.

5.2 To describe Autotrophism.

5.3 To name some Autotrophic organisms.

6.0 To know about Heterotrophism.

6.1 To describe Heterotrophism.

6.2 To name some Heterotrophic organisms.

7.0 To know the definition of Ecology.

7.1 To describe Ecology

7.2 To define it.

CHAPTER ONE : Autotrophism

General objectives:

Cognitive Domain

1.0 To write about the process of Photosynthesis.

1.1 To understand Van Helmont's experiment.

1.2 To demonstrate (experimentally) the absorbtion of CO_2 by green plants.

1.3 To know Ingenhousz's experiment.

1.4 To demonstrate the starch formation in green plants.

1.5 To demonstrate the role of CO_2 in starch formation.

1.6 To know the structure of the chloroplast in green leaves.

1.7 To know different pigments inside the chloroplast.

1.8 To distinguish the importance of chloroplast in photosynthesis.

1.9 To know the mechanism of photosynthesis.

1.10 To understand the formation of organic materials in photosynthesis.

2.0 To know basic concepts of chemosynthesis.

3.0 To know the similarities and differences between photosynthesis and chemosynthesis.

4.0 To understand the importance of autotrophism as in the food production for organisms.

5.0 To know the principles of the energy loss in nature.

Specific objectives

1.1 To understand Van Helmont's experiment.

1.11 To describe Van Helmont's experiment.

1.12 To summarize its results.

1.13 To explain the fallacies of Van Helmont's reasoning.

1.2 To demonstrate (experimentally) the absorbtion of CO_2 by green plants.

1.21 To identify a suitable indicator for detection of CO_2

1.22 To describe the design of an experiment with this indicator.

1.23 To explain the colour change of the indicator.

1.24 To relate the principle of respiration to the colour change of the indicator.

1.25 To discover that the green plant absorbs CO_2 in the presence of light.

1.3 To know Ingenhousz's experiment.

1.31 To describe Ingenhousz's experiment.

1.32 To identify the properties of oxygen.

1.33 To outline the release of oxygen by green plants.

1.34 To state the effect of light on this process.

1.4 To demonstrate starch formation in green plants.

1.41 To describe the test for starch.

1.42 To extend its use for detecting the presence of starch in green leaves.

1.43 To describe the procedure of the experiment correctly.

1.44 To relate the starch formation with the presence of light.

1.5 To demonstrate the role of CO_2 in starch formation.

1.51 To describe the procedure of the experiment.

1.52 To relate the result of this experiment with those obtained in 1.41.

1.53 To describe the role of potassium hydroxide.

1.54 To describe the role of potassium bicarbonate.

1.55 To discover that CO_2 was involved in starch formation.

1.6 To know the structure of the chloroplast in green leaves.

1.61 To name the basic parts of a leaf in a microphotograph.

1.62 To identify the location of chloroplast in cells.

1.63 To describe the structure of chloroplast.

1.7 To know different pigments inside a chloroplast.

1.71 To describe chromatography procedure.

1.72 To name different pigments.

1.73 To identify them by their colours.

1.8 To distinguish the importance of chloroplasts in photosynthesis.

1.81 To describe Hill's experiment.

1.82 To explain the role of chloroplasts in "trapping" light energy.

1.83 To relate the previous knowledge to the function of chloroplast.

1.9 To know the mechanism of photosynthesis.

1.91 To describe light reactions.

1.92 To describe dark reactions.

1.10 To understand the formation of organic materials in photosynthesis.

1.101 To describe the formation of starch.

1.102 To infer the formation of other organic materials by the same principle.

2.0 To know basic principles of chemosynthesis.

2.1 To name some chemosynthetic organisms.

2.2 To describe the basic principles.

3.0 To know the similarities and differences between photo and chemosynthesis

3.1 To identify the basic principles involved in both processes.

3.2 To identify the differences between these two processes.

4.0 To understand the importance of autotrophism as the process of food production for other organisms.

4.1 To name different kinds of autotrophism.

4.2 To summarize food production and the feeding habits of organisms.

5.0 To know the principles of loss of energy in nature.

5.1 To define the law of energy conversion.

5.2 To describe energy conversion in organisms.

5.3 To describe the importance of such a study.

Affective domain

1.0 To complete assigned homework.

1.1 To answer some of the questions.

1.2 To read some of the references.

2.0 To demonstrate a problem-solving attitude.

2.1 To modify the experiment in the assigned homework.

3.0 To display safety consciousness in performing experiments.

4.0 To practice co-operation in group activities.

Manual skills:

1.0 To set up laboratory experiments quickly and correctly.

1.1 To identify apparatus.

1.2 To assemble the apparatus correctly in the time available.

2.0 To perform basic laboratory techniques with care and safety.

2.1 To know the safety rules.

2.2 To apply them in laboratory techniques.

CHAPTER TWO : Heterotrophism

General objectives:

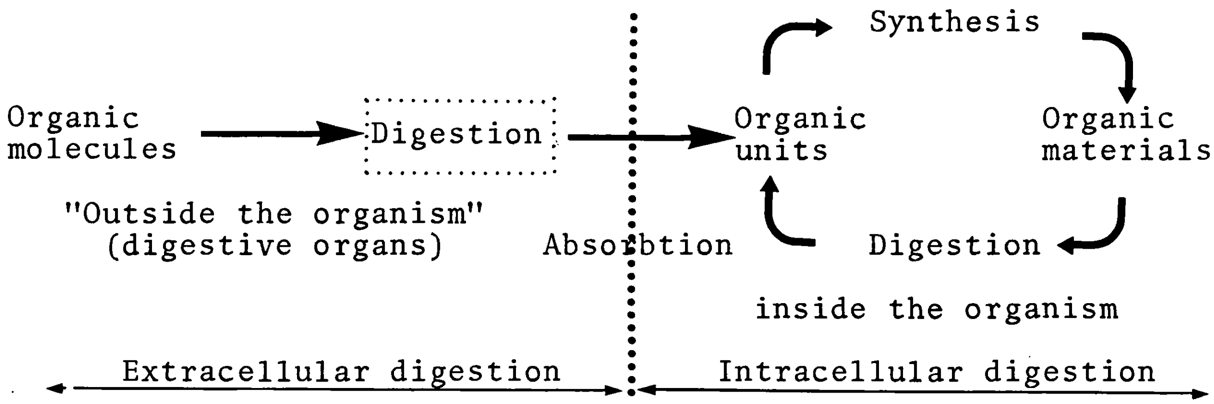
Cognitive Domain

1.0 To know the need for digesting organic materials in Heterotrophism.

2.0 To understand the basic principles of digestion.

3.0 To know the basic concept of synthesis.

4.0 To understand the application of the following model, through familiar examples in man.



5.0 To know the diversity of digestive organis in Heterotrophs.

Specific objectives

1.0 To know the need for digestion of organic materials In Heterotrophs.

1.1 To describe criteria needed for the absorbtion of organic molecules e.g. Solubility.

1.2 To recall the functional units of the basic groups of organic materials.

1.3 To recall the function of digestive enzymes on organic molecules.

2.0 To understand the basic principles in digestion.

2.1 To define digestion as a process of converting large organic molecules into smaller, diffusable ones.

2.2 To describe the function of digestive enzymes existing in cells and in the digestive organ.

2.3 To identify intracellular and extracellular digestion.

3.0 To know the basic principle of synthesis.

3.1 To define synthesis as a process of converting the functional large units of organic molecules into a variety of smaller organic molecules.

3.2 To describe that this process takes place only in cells.

3.3 To identify this process in examples.

4.0 To understand the model:

4.1 To identify the difference between digestion and synthesis.

4.2 To distinguish the parts that refer to intra-cellular and extracellular digestion in the diagram.

4.3 To give examples e.g. glucose/glycogen cycle for the model.

5.0 To know the diversity of digestive organs in Heterotrophs.

5.1 To describe the main types of the digestive organs.

5.2 To identify them from their diagrams.

5.3 To name examples of each type.

Affective domain

1.0 To complete assigned homework.

1.1 To answer some of the questions.

1.2 To read some of the references.

1.3 To report the results of the experiments performed by pupils at home.

Psychomotor domain

1.0 To draw an accurate and simple diagram of the digestive organs.

2.0 To perform the experiment on Bread-mould with simple apparatus.

CHAPTER THREE : Ecosystem Structure

General objectives:

Cognitive Domain

1.0 To understand the structure of the ecosystem.

2.0 To know about biotic factors.

3.0 To understand the abiotic factors.

4.0 To know the relationship between these two factors.

5.0 To know the effect of pollutants on the ecosystems.

Specific objectives:

1.0 To understand the structure of ecosystem.

1.1 To describe the concept of the ecosystem.

1.2 To name examples of different ecosystems.

1.3 To distinguish between biotic and abiotic factors.

2.0 To know about biotic factors.

2.1 To identify producers, consumers and decomposers as the biotic factors.

2.2 To name examples for each categories.

2.3 To identify biotic factors in the ecosystem.

3.0 To understand abiotic factors.

3.1 To name the main abiotic factors e.g. temperature, light, gases, chemicals etc.

3.2 To explain the significance of each factor in the ecosystem.

4.0 To know the relationship between biotic and abiotic factors.

4.1 To describe some animal behaviour patterns related to environmental abiotic factors.

4.2 To identify the ways these factors affect biotic factors.

5.0 To know the effect of pollutants on the ecosystem.

5.1 To identify the pollutants.

5.2 To describe their effects.

Affective domain

1.0 To complete assigned homework.

1.1 To answer some of the questions.

1.2 To read some of the references.

1.3 To report the experiments he has performed at home.

Psychomotor domain

1.0 To perform the experiment on pollution correctly.

1.1 To perform the techniques correctly.

1.2 To present the results in a comprehensible exhibition.

CHAPTER FOUR : The functions of Ecosystem

General objectives

Cognitive Domain

1.0 To know the law of conservation of energy.

2.0 To know the principle of energy conversion in the ecosystem.

3.0 To know the pyramid of energy.

4.0 To understand the pyramid of mass.

5.0 To know the pyramid of numbers.

6.0 To know the food chain.

7.0 To apply the concept of food chains to the pyramid of energy.

8.0 To understand the food web.

9.0 To recognize the process of organo-chemical cycle.

10.0 To understand the process of the carbon cycle.

11.0 To understand the procedure of succession.

12.0 To understand the agronomic importance of succession.

Specific objectives

1.0 To know the law of conservation of energy.

1.1 To name different kinds of energy.

1.2 To describe energy conversions.

1.3 To define the law of conservation of energy.

2.0 To know the principle of energy conversion in the ecosystem.

2.1 To identify the kinds of energy conversion which occur in organisms.

2.2 To describe the vital process involved in energy conversion.

3.0 To know the pyramid of energy.

3.1 To identify the existence of at least one producer and some consumers.

3.2 To describe the relation between these organisms and the hierarchy of consumers (e.g. primary consumer etc.).

3.3 To outline the energy wastage and identify the vital processes involved in this loss of energy.

3.4 To know the flow of energy from one organism to another via organic materials (food) in the pyramid of energy.

4.0 To understand the pyramid of mass.

4.1 To describe the characteristics of the pyramid of mass.

4.2 To identify the loss of mass from producers to consumers.

4.3 To give an example of this pyramid from an ecosystem.

5.0 To understand the pyramid of numbers.

5.1 To describe pyramid of numbers.

5.2 To explain the pyramid of numbers as another expression of the pyramid of mass.

5.3 To explain the pyramid of numbers as another expression of the pyramid of energy.

6.0 To know the food chain.

6.1 To describe the food chain.

6.2 To identify the feeding habits of the organisms involved (producer, herbivore and carnivore).

7.0 To apply the concept of the good chain to the pyramid of energy.

7.1 To show that both concepts describe the same principle.

8.0 To understand the food web.

8.1 To identify independent food chains in the system.

8.2 To outline the diversity of feeding habits as one of the reasons for interrelating the food chains

8.3 To explain that living organisms do not limit themselves to one food resource.

9.0 To recognize the process of organo-chemical cycle.

9.1 To understand the flow of energy and mass via food from one organism to another.

9.2 To recall the role of decomposer in decomposing the organic materials into simple chemicals.

9.3 To relate the use of simple chemicals by autotroph organism and their conversion into organic molecules.

10.0 To understand the process of carbon-cycle.

10.1 To identify the source of carbon in nature.

10.2 To state that carbon is the basic element in the chemical structure of organic materials.

10.3 To explain the organo-chemical principle applying to the carbon-cycle.

11.0 To understand the procedure of succession.

11.1 To define succession.

11.2 To name some examples from the local area.

11.3 To explain the mechanism of succession.

12.0 To understand the agronomic importance of succession.

12.1 To identify some examples of artificial succession introduced by man.

12.2 To explain these examples from the point of agronomic importance.

Affective domain

1.0 To complete assigned homework.

1.1 To answer some of the questions.

1.2 To read some of the references.

2.0 To recognize the importance of study of the organo-chemical cycle for the welfare of man.

2.1 To identify the danger of atomic explosions.

2.2 To appreciate the role of science in explaining the danger caused by Strontium 90.

CHAPTER FIVE : Population

General Objectives

Cognitive Domain

1.0 To know about population.

2.0 To understand population density.

3.0 To demonstrate correct usage of the sampling technique in studying population density.

4.0 To understand factors affecting population density.

5.0 To recognize mechanism of population changes.

6.0 To apply the principle of population dynamics to the study of human populations.

Specific objectives

1.0 To know about population.

1.1 To define the term population.

1.2 To name examples for the concept of population.

2.0 To understand population density.

2.1 To define the concept of population density.

2.2 To identify the equation of $D = \frac{N}{S}$ or alternative $D = \frac{N}{V}$ as the expression of population density.

2.3 To describe the symbols used in the above formula.

3.0 To demonstrate correct usage of the sampling technique in studying population density.

3.1 To describe the procedure of the sampling technique.

3.2 To explain the method of calculating the results.

3.3 To give an example for its usage.

3.4 To predict its accuracy by an experimental approach.

4.0 To understand factors affecting population density.

4.1 To identify factors affecting population density.

4.2 To describe their effect on population density.

4.3 To distinguish dependent and independent factors.

4.4 To explain the effect of each category on population density.

5.0 To recognize the mechanism of population changes.

5.1 To describe the process of population growth.

5.2 To identify different patterns in population growth.

5.3 To explain each pattern in terms of the change caused by biotic or abiotic factors.

5.4 To distinguish between changes resulting from the effect of dependent and independent factors.

6.0 To apply the principle of population dynamics to the study of human populations.

6.1 To identify dependent and independent factors in human population.

6.2 To describe the effect of each factor on population density.

6.3 To explain human population growth.

6.4 To discover problems caused by population growth.

Affective Domain

1.0 To complete assigned homework.

1.1 To answer some of the questions.

1.2 To read some of the references.

1.3 To report on his/her own investigations to the class.

2.0 To propose a plan for population control.

2.1 To explain his/her reasons for population control.

2.2 To relate it to the problems resulting from over population.

Psychomotor Domain

1.0 To perform the sampling technique for estimating the population of earthworms in the school ground.

2.0 To perform an experiment to prove the accuracy of the sampling method.

CHAPTER SIX : Interaction in ecosystems

General objectives

Cognitive Domain

1.0 To know about interaction.

2.0 To understand territoriality.

3.0 To know about peck-order.

4.0 To know about symbiosis.

5.0 To know about mutualism.

6.0 To know about commensalism.

7.0 To know about parasitism.

8.0 To know about predation.

Specific objectives

1.0 To know about interaction.

1.1 To define interaction.

1.2 To describe the reason of interaction amongst organism.

1.3 To name different types of interaction.

2.0 To understand territoriality.

2.1 To identify the communication symbols and media used amongst animals to protect their territory.

2.2 To explain the function of these media in territoriality.

2.3 To identify these types of behaviour in familiar and common local animals.

3.0 To know about peck-order.

3.1 To describe peck-order.

3.2 To identify it in examples.

4.0 To know about symbiosis.

4.1 To define the term symbiosis.

4.2 To identify different kinds of symbiosis.

5.0 To know about mutualism.

5.1 To define mutualism.

5.2 To identify it in an example.

6.0 To know about commensalism.

6.1 To define it.

6.2 To identify it in an example.

7.0 To know about parasitism.

7.1 To define it.

7.2 To identify a parasite and a host.

7.3 To describe the relation between parasite and host.

7.4 To name some examples for ecto- and endo-parasites.

8.0 To know about predation.

8.1 To define predation.

8.2 To describe the interaction between prey and predator.

8.3 To name some predators.

8.4 To describe the correlation between population density of the predator and prey.

8.5 To identify the interaction amongst predators due to their feeding habits.

Affective domain

1.0 To complete assigned homework.

1.1 To answer all the questions.

1.2 To read some of the references.

2.0 To report his/her observations about interaction to the class.

CHAPTER SEVEN : Aquatic Ecosystems

General objectives

Cognitive Domain

1.0 To know about factors affecting aquatic ecosystems.

2.0 To know about biotic factors of seawater.

3.0 To know about biotic factors of freshwater.

4.0 To understand the effect of man on the aquatic ecosystems.

Specific objectives

1.0 To know about factors affecting aquatic ecosystems.

1.1 To name these factors.

1.2 To describe their effects.

2.0 To know about biotic factors of the sea.

2.1 To identify producers, consumers and decomposers.

2.2 To identify the phytoplanktons as the major sea producer.

2.3 To identify the zooplanktons as the major primary consumer.

2.4 To name some other sea consumers.

3.0 To know about biotic factors of the freshwater ecosystem.

3.1 To identify the freshwater producers.

3.2 To identify the freshwater consumers.

4.0 To understand the effect of man on the aquatic ecosystem.

4.1 To identify some of the man-made pollutants.

4.2 To describe the effect of these pollutants on an aquatic ecosystem.

4.3 To explain the other interferences by man in aquatic ecosystems.

Affective domain

1.0 To complete assigned homework.

1.1 To answer all the questions.

1.2 To read the references.

2.0 To report some of his observations to the class.

CHAPTER EIGHT : Terrestrial Ecosystems

General objectives

Cognitive Domain

1.0 To know about different types of terrestrial ecosystems.

2.0 To understand the structure of a Tundra ecosystem.

3.0 To understand the structure of a coniferous forest.

4.0 To understand the structure of a deciduous forest.

5.0 To understand the structure of a temperate forest.

6.0 To understand the structure of a grassland ecosystem.

7.0 To understand the structure of a desert ecosystem.

8.0 To understand the polluting effect of mans' activities on terrestrial ecosystems.

Specific objectives

1.0 To know about different types of terrestrial ecosystems.

1.1 To identify different types from their descriptions.

1.2 To name the main types.

2.0 To understand a tundra ecosystem.

2.1 To define the term "tundra".

2.2 To identify some Tundra biotic factors.

2.3 To explain the graph showing yearly temperature and rate of rain in a Tundra region.

2.4 To identify some adaptive characteristics in the Tundra organisms.

3.0 To understand the structure of coniferous forest.

3.1 To define the term "coniferous forest".

3.2 To identify the biotic factors.

3.3 To explain the graph.

3.4 To identify some adaptive characteristics of the organisms living in this ecosystem.

4.0 To understand the structure of deciduous forest.

4.1 To define the term "deciduous forest".

4.2 To identify the biotic factors.

4.3 To explain the graph.

4.4 To identify some of the adaptive characteristics amongst organisms living in this ecosystem.

5.0 To understand the structure of Temperate forests.

5.1 To define the term "Temperate forest".

5.2 To identify the biotic factors.

5.3 To explain the graph.

5.4 To identify some of the adaptive characteristics existing amongst organisms living in this ecosystem.

6.0 To understand the structure of grassland ecosystems.

6.1 To define the term "grassland ecosystem".

6.2 To identify its biotic factors.

6.3 To explain the graph.

6.4 To identify characteristics of the organisms of this ecosystem.

7.0 To understand the structure of desert ecosystems.

7.1 To define the term "Desert".

7.2 To identify its biotic factors.

7.3 To explain the graph.

7.4 To identify some of the characteristics of the organisms living in this ecosystem.

8.0 To understand the effect of man on terrestrial ecosystems.

8.1 To identify the importance of terrestrial ecosystems for man.

8.2 To identify some of the pollutants.

8.3 To explain the effect of pollutants on the biotic factors.

Affective domain

1.0 To complete assigned homework.

1.1 To answer all the questions.

1.2 To read the references.

2.0 To report his/her observations about pollution to the class.

3.0 To report his/her observations on biotic factors of any ecosystem to the class.

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29. Gronlund, N.E. (1970). *Op.cit.*, pp.51-52.

APPENDIX 3

The Analysis of the Biology Curriculum

Section I Description of Materials.

1.1. Introduction of the materials.

1.11 Description of the textbook:

Daneshfar, H., Hashemi, J.T.(1975) "Biology and Hygiene" Vol I, 2nd ed., Tehran, Ministry of Education, Iranian Book Organization. In Farsi.

1.12 Author's Rationale:

The material tries to provide basic knowledge about Biology and Hygiene. It is hoped that the management of the content and its mode of presentation create a positive attitude towards the subject.

1.13 Target population:

The target population is the first year students of the Theoretical or Comprehensive secondary education. The age range varies from 14 to 16, depending on their previous achievement. 90% of this population are in a transitional stage and may choose other subjects in vocational or comprehensive schools afterwards. Therefore they may not study Biology and Hygiene as an academic course.

All students have studied combined science for three years of the Guidance Cycle level and have passed the Third year examination, at the same level.

1.14 Examination is solely administered and governed by the class teacher. There is a written exam at the end of each term. In the third term the whole syllabus is assessed and has double credit. Occasional oral questions in the classroom might be considered as an oral exam, but mostly it is the result of the written exams which is decisive in success or failure of the students.

Examination papers are prepared by the subject teacher and mainly consist of essay type or short- answered questions.

1.15 School Time-table:

The School year starts on 9th October (1st Mehr) each year and ends on 22nd June (30th Khordad) of the next Iranian year. Schools run from Saturday to Friday weekly. Friday is the weekend holiday.

Apart from Bank holidays and others, there is a new year holiday from 17th March to 5th April and summer holiday from 22nd June to 9th October. Most of June is spent in taking final examinations.

An example of a typical school weekly time-table is represented by the following schedule. There must be 5-6 teaching sessions in a day (not more than 36 hours per week). The management of these hours differs from one school to another, depending on the type of school or the location. As an example: in most localities girls schools finish their daily programme earlier than boys' (by omitting one of the recessions from the time-table). This is due to the Islamic Culture and aims to keep the two sexes separate.

Days of the week

Time	Sat.	Sun.	Mon.	Tues.	Wed.	Thurs.	
9.00-9.50							
							Break
10.05-10.55							
							Break
11.10-12.00							
							Break
2.00-2.50							
							Break
3.05-4.00							

Table 1 - An example of a school daily time-table

1.16 Pupil's Ability:

A mixed abilities group is common but, in some schools students are grouped according to their previous years achievement. Usually the average total mark is used as a criterion for this grouping.

1.17.School Situation:

Schools are mostly grammar type where students are prepared to take the final examination and university entrance examinations. But the new system of education has introduced few comprehensive schools where a variety of subjects is available. The increasing number of vocational schools also provides further opportunities for different abilities and interests.

Classes consist of 35-50 students.Most are equipped with a blackboard which is the only teaching apparatus.

1.18 Testing and revision prior to publication.

d) Each section of the textbook was separately taught to a representative sample of students of the same age group. Experiments were tried and discussed with pupils. Questions were tested and revised through an interview with the same age group.

b) A draft copy of the book was examined by three specialists for subject accuracy.

c) Language style, consistency of the words and grammatical patterns and other technical aspects were checked by a subject editor and a language expert.

Section II - Content Analysis of Chapter 1-8

Title	Pages
Section One - The web of life	8
1 - Autotrophism:	6
Photosynthesis (16), Chemosynthesis (21), comparison of photosynthesis with chemosynthesis (21), Energy economics in living creatures (23)	
2 - Heterotrophism:	29
Digestion and Synthesis (29)	
3 - Ecosystem and its structure:	37
Structure of Ecosystem (38)	
4 - Functions of Ecosystem:	45
Energy Flow (45), Nutrient Cycle (48), Succession another function of ecosystem (52).	
5 - Population, as a unit of an Ecosystem:	56
Density (56), Factors affecting population density (60), population changes, growth and equilibrium (62), Problem of human population (63)	
6 - Interactions within Ecosystems:	69
Competition (69), Symbiosis (70), Predation (76)	
7 - Aquatic Ecosystems:	78
Some general characteristics of aquatic ecosystems (78), Marine ecosystems (79), Fresh-water ecosystem (81).	

8 - Terrestrial Ecosystems:
Tundra (84), Coniferous forest (86), Decidious forest (87), Tropical forests (89), Grassland (90), Desert (91), Man and Terrestrial ecosystems (92).

2.2 -The quantitive analysis of the contents of this analysis is shown in Table 1, page 7.

2.3- The development of the main concepts in the content.

This procedure has been summarized in Fig.1,p 8.

2.4- The detailed content analysis of Chapter 1-8.

In this analysis, the following steps have been exercised

A) Technical terms: refers to all the new terms introduced, for the first time, in the chapter. However, if a term is used, in different context, in another chapter; this has been indicated by an asterisk.

B) Distribution of the contents within a chapter.

C) Details and sequences of the main concepts and principles in a chapter.

D) Pattern of the development of the main concepts and principles.

E) Description of the illustrations.

F) Comments.

Chapter Title / Categories	Page No.	Text only	Illustration only	Text + Illus	Summary	Questions	Activities	References	No. of pages	No. of experi-ments in tex	No. of experi-ments in activi	Comments
1-Autotrophism	6-27	8.95	9.30	18.23	0.3	2.0	1.3	0.5	23	7	1	intro: not incld:
2-Heterotrophism	29-36	2.6	1.73	2.33	0.5	1.5	0.6	0.45	8	-	1	
3-Ecos.:Structure	37-44	4.4	1.75	6.15	0.2	0.45	0.5	0.25	8	-	1	
4-Ecos.:Function	45-55	4.4	4.8	8.20	0.25	0.5	-	0.3	11	-	-	
5-Population	56-68	8.05	3.4	11.45	0.2	0.35	0.10	0.25	13	-	2	
6-Interaction	69-77	3.90	3.70	7.60	0.1	0.4	-	0.45	9	-	-	
7-Aquatic Ecos.	78-83	3.05	0.8	3.85	0.2	0.65	0.05	0.45	6	-	1	
8-Terrestrial Ecos	84-96	5.25	4.95	10.2	0.3	0.45	0.15	0.4	13	-	2	
Total	100	40.60	30.43	71.03	2.05	6.10	2.60	3.05	91	7	8	

Table 1. The quantitative analysis of the text book. Showing percentage of page cover of each category.

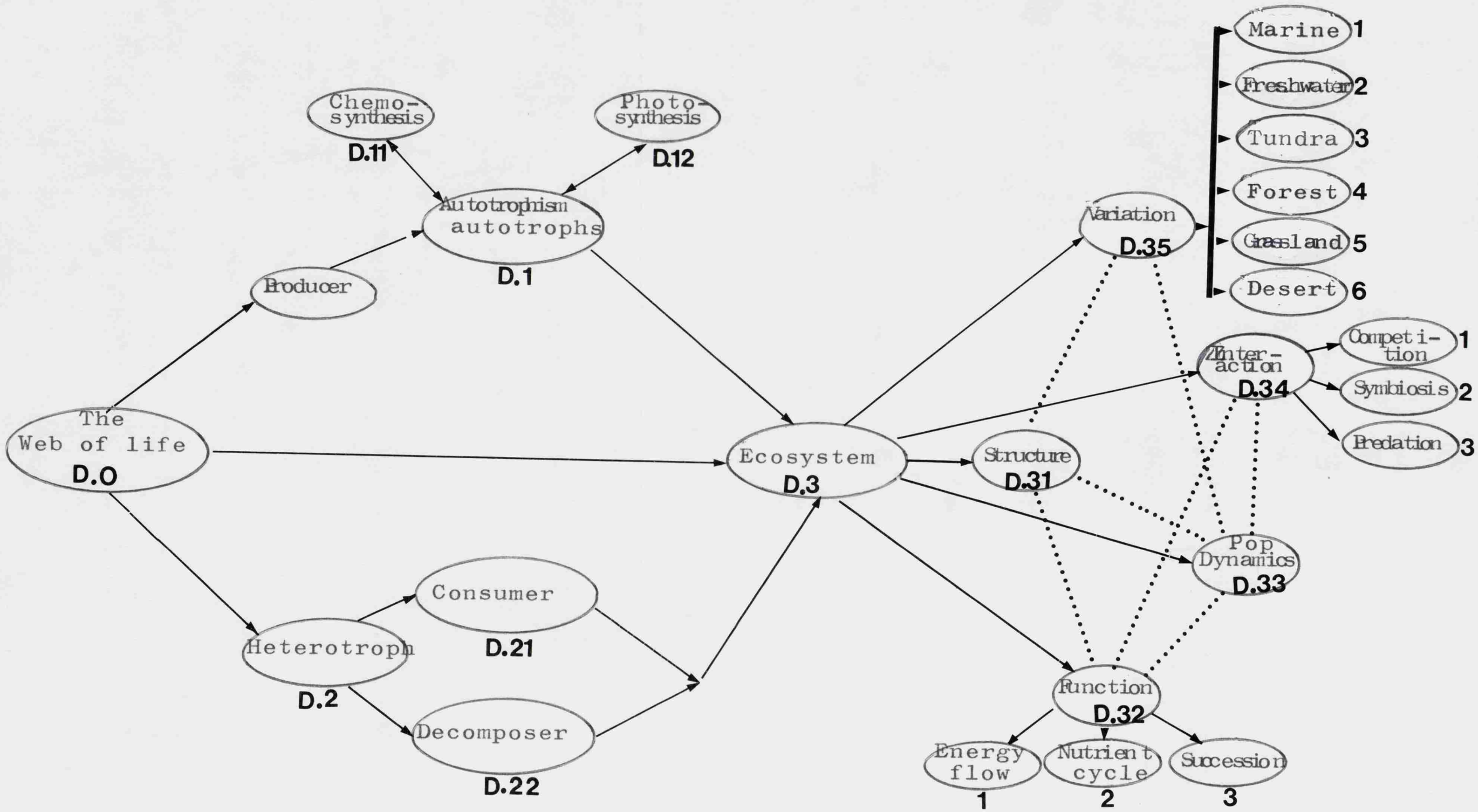


Figure 1 - The development of the main domains in the text-book. Numbers specify each domain and indicate its sequential appearance in the text. The solid lines indicate strong relationship between domains and dotted lines the loose relationship between some elements of one domain with another.

Section One - The web of life.

A. Technical Terms:

Autotroph	Ecology	Heterotroph
Autotrophism	Energy	Heterotrophism
Consume	Environment	Molecule
Consumer	Food	Nutrient
Decompose	Greenplant	Potential energy
Decomposer	Growth	Producer
		Radiant energy

C. Details and sequence of the concepts & principles:

C.1 Observation of the feeding habits of familiar living creatures to show that they are using each other (consuming) to obtain organic substances.

C.2 The concept of consumer and decomposer introduced and related to the feeding habits and source of food. Emphasis is made on food as organic substances.

C.3 Argument that a third group, producer, is needed to supply the organic materials continuously.

C.4 Discussion of the relationship between the three groups to emphasise the interdependence existing amongst them.

C.5 Revision of previous knowledge of students about green plants and their abilities to utilise nutrients, light energy and water to make organic food compounds from inorganic matter.

C.6 Argument that green plants are "the producers" of organic materials.

C.7 The green plants are self sufficient in the production of organic compounds, thus they are able to nourish themselves, therefore they are called Autotrophs and their feeding habit is called Autotrophism.

C.8 By the same reasoning, consumers and decomposers are Heterotrophs since they are unable to make organic compounds and use others' organic compounds. Their feeding habit is called Heterotrophism.

C.9 Definition of "Ecology" as the study of the interaction between organisms and their environment.

E. Illustrations

Fig.1, p.4. "Relationship between producers, consumers and decomposers". Process figure showing the transformation of matter from one group of organisms to another.

Fig.ii, p.5. "Autotrophs are able to produce organic compounds and store energy in their molecules." A simplification of the input and output of photo-synthesis.

F. Comments.

This introduction covers the main points of the whole syllabus. Each point made is to be expanded and discussed in the following chapters. However most emphasis is laid on the photosynthetic autotrophs.

Chapter 1 : Autotrophism:

A - Technical Terms:

Aquatic plant
Bicarbonate - indicator
Bromo-Thymol blue
Capillary force
Carbohydrate
Carbondioxide
Chemosynthetic
Chemosynthesis
Chlotoplast
Chlorophyll
Chromatography
Dark stage
Dicotyledon
Energy economic
Epidermis
Enzyme
Fat
Green algae
Glucose
Ingenhousz's experiment
Iron bacteria
Light stage
Mesophyll
Photosynthetic
Photosynthesis
Protein
Potassium hydroxide
Respiration
Starch
Sugar
Sulphur bacteria
Thermal energy
Van Helment's experiment.

B - Distribution of sub-titles in Chapter 1:

P = Page number A = Text only B = Illustration only % = per cent

Sub-titles in Chap 1	P	A	B	A+B	A%	B%	A% + B%
Photosynthesis	6	4	2.25	6.25	17.4	9.79	27.19
- Leaf structure	12	1	3	4	4.35	13.50	17.40
- Light & photosynthesis.	16	0.25	0.25	0.5	1.09	1.09	2.18
- Mechanism of photo-	16	1.5	1.0	2.5	6.53	4.35	10.88
Chemosynthesis	19	1.0	1.5	2.5	4.35	6.53	10.88
Comparing photo & Chemo	21	0.2	0.5	0.7	0.87	2.18	3.05
Energy economics	22	1.0	0.8	1.8	4.35	3.48	7.83
		8.95	9.30	18.25	34.59	40.47	79.39
Summary	24	0.3	-	0.3	1.31	0.0	1.31
Question & Self assess	24	1.4	0.6	2.0	6.09	2.61	8.70
Activities	26	0.5	0.8	1.3	2.18	3.48	5.66
References	27	0.5	-	0.5	2.18	-	2.18
Total	6-27	11.65	10.7	22.35	50.70	46.5	97.26

C Details and sequence of the concepts and principles:

Photosynthesis:

C1 Introduction of the word photosynthesis as "the ability to synthesise Inorganic materials by the use of light energy" into complex organic plant foods.

C2 Van Helmont's experiment is discussed to pose the necessity of other nutrients, rather than water and minerals for the growth of green plants.

C3 An experiment with either Bromo-Thymol blue or Bicarbonate indicator is carried out to prove the absorption of CO_2 by a green plant in the presence of light energy.

C4 Discussion of Ingenhouze experiment which provides evidence that only the foliage of the plant releases oxygen in the presence of light.

C5 A follow up discussion reviews the early concept of photosynthesis in the light of new discoveries.

C6 Practical experiment proves that starch (an organic compound) is produced in the presence of light, in the green part of the plant.

C7 Demonstration experiment by the teacher proves that CO_2 is needed for starch formation.
A question is posed about the site of photosynthesis.

C8 Structure of a leaf. Microscopic study of the structure of a leaf shows it consists of Epidermis, Mesophyll and vessels. Mesophyll contains chloroplasts. Electron micrograph of chloroplast section shows the site of chlorophyll in the green part of the plants.

C9 Paper-chromatography experiment shows the existence of other pigments in addition to chlorophyll, in the green part of the plants.

C10 Light and chlorophyll. Discussion of Hill's experiment to specify the function of light in activity the chloroplast to absorb CO_2 and release oxygen.

C11 Mechanism of photosynthesis. A review and generalisation of the previous sections about photosynthesis.

C12 Synthesis of organic materials. A deductive generalisation of the synthesis of organic compounds eg. if starch is made the existence of oily seeds proves that oil could be made as well, etc.

Chemosynthesis:

C13 Discussion. Some bacteria like iron and sulphur bacteria can use the chemical energy of chemicals to produce organic compounds from CO_2, water and minerals.

Comparing Photosynthesis and Chemosynthesis.

C14 The only difference is their source of energy.

D Pattern of the development of the main concepts and principles is shown in Fig.2.

E Illustrations

Fig 1 - 1. "Van Helmont's experiment". The drawing shows the process of the experiment.

Fig 1 - 2. "Do green plants use atmospheric Carbon Dioxide?"

Experiment shows the use of Bromo-thymol indicator for investigating the use of carbon dioxide by an aquatic plant.

Fig 1 - 3. "Ingenhousz" Experiment

Fig 1 - 4. "Method of testing starch in a leaf". The flow diagram shows the procedure of the experiment.

Fig 1 - 5. "In which one of these two leaves is starch formed? Why?" The drawing shows an experiment for testing starch formation in leaves under different conditions.

Fig 1 - 6. "Internal Structure of Dicotyledon leaf in trans-section". The photo micrograph shows the trans-section of a leaf and close up enlargement of different areas.

Fig 1 - 7. "Study of the structure of chloroplasts with electron microscope" The microphotograph of chloroplast shows the site of photosynthesis.

Fig 1 - 8. "Chromatography method to separate leaf pigments.

Fig 1 - 9. Characteristics of a photosynthetic organ". The process diagram shows in sequential steps what characteristics have made the leaf the most suitable organ for photosynthesis.

Fig 1 - 10 "Chlorophyll molecules release axygen in the presence of light" Diagramatic representation of Hill's experiment.

Fig 1 - 11. "Summary of the reactions taking place in the process of photosynthesis."

Fig 1 - 12. "One sulphur bacteria X by 31,000. Electron microscope".

Fig 1 - 13. Summary of chemosynthesis in the sulphur and iron bacteria.

Fig 1 - 14. "Comparison between photosynthesis and chemosynthesis.

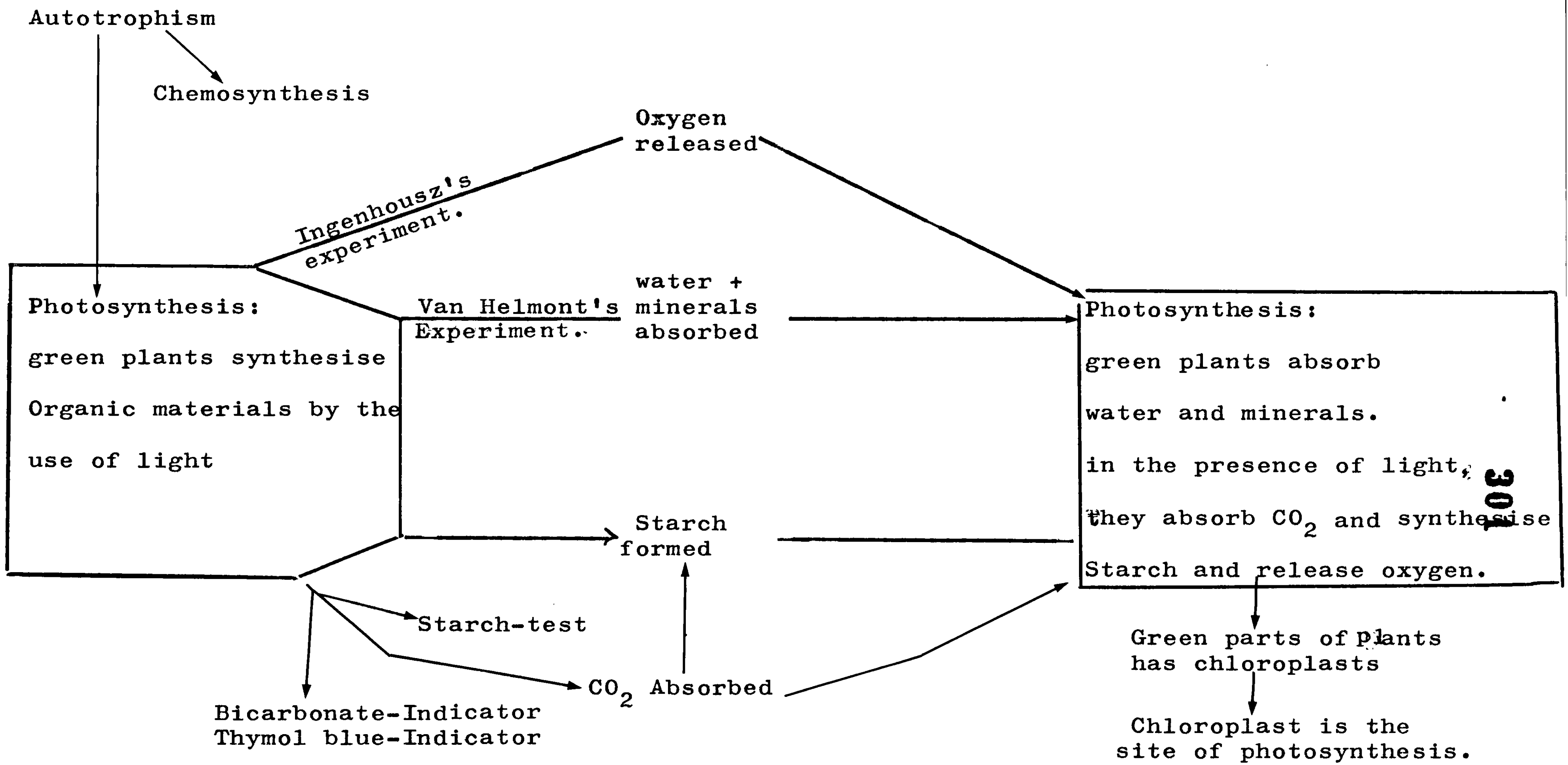


Figure 2: The presentation of materials in Chapter One.

Chapter 2 : Heterotrophism:

A: Technical Terms:

Absorbtion

Animal Starch

Cell

Cell membrane

Crustacea

Digested food

Digestion

Digestive

Digestive cavity

Digestive enzyme

Digestive tube

Extracellular

Extracellular digestion

Fatty acid

Giant molecule

Glycerol

Hydra

Interacellular

Interacellular digestion

Molecular units

Membrane

Pathogenic

Pathogenic bacteria

Phagocytosis

Prey

Stomach

Synthesis

Tantacle

Vacuole

Water soluble

White blood corpuscle

Worm.

B - Distribution of subtitles in Chapter 2:

P = page no. A = text only. B= illustration only. % per cent

Subtitles in Chap: 2.	P	A	B	A+B	A%	B%	A% + B%
Heterotrophism	29	0.5	0.23	0.73	6.25	2.88	9.13
Digestion & Synthesis	29	1.0	-	1.0	12.5	-	12.5
Variation & Heterotroph ie. digestion	30	1.1	1.5	2.6	13.75	18.75	32.50
		2.6	1.73	2.33	32.00	21.63	54.13
Summary	33	0.5	-	0.5	6.25	-	6.25
Question & Self Asses.	34	1.0	0.5	1.5	12.5	6.25	18.75
Activities outside Classroom	35	0.6	-	0.6	7.5	-	7.5
References	36	0.45	-	0.45	5.62	-	5.62
Total Coverage	29-36	5.15	1.23	6.38	63.87	27.88	92.25

C. Details and sequence of the concepts and principles.

Heterotrophism

C1 The organic substances obtained by Heterotrophs cannot be used as they are, because: a) their molecular sizes are mostly large and b) they are not water soluble. Therefore these molecules cannot pass the cell membrane.

C2 Digestion is a process that breaks down organic molecules such as proteins, fats and carbohydrates into small or molecular units. Amino acids, fatty acids and glycerol & simple sugars, (eg. glucose) respectively. These smaller molecules can be absorbed by the cell membrane.

C3 The absorbed molecules are either used by cells in synthesis of new organic compounds or are used for their chemical energy.

C4 Digestion and synthesis of molecules. The digestion and synthesis of molecules are carried on by the help of enzymes. The example for these two processes is the digestion of starch in the digestive tact, into glucose, and conversion of glucose into glycogen in the liver and body cells. The digestion of glycogen in the cells takes place when the cells need it.

C5 Digestion and synthesis of molecules can be intra-cellular or extracellular. The first example is common in both heterotrophs and autotrophs.

C6 The variation of digestion in Heterotrophs: Digestion in Heterotrophs can only be intracellular (eg phagocytosis in Amoeba); or both intra - and extracellular (eg Hydra); or only extra-cellular (man)

C7 The variety of digestive organs are: vacuole; cavity; or a tube.

D Organisation of the content. The concepts have developed in the following pattern:

Organic compounds
protein, fats, carbohydrates
(big molecules indiffusable from cell membranes)

out
Synthesis in cells ← Enzymes → Digestion in cells or digestive organ
in

in
out

organic compound units
Amino acids, fatty acid & glycerol
-oses eg. glucose.
(Diffusable and small molecules)

example:

starch —in→ Digestive organ —out→ glucose → Synthesis in cell → glycogen → digestion in cells → glucose

E Illustrations

Fig 2.1. "Digestion is the process of destruction of large organic molecules into small diffusable molecules by the help of digestive enzymes." The drawing shows an organic molecule digested into small diffusable molecules which can pass the cell membrane.

Fig 2.2. "Formation of digestive vacuole in Amoeba"

Fig 2.3. "Different stages of food catching by Hydra"

"Cell structure of body wall".

Fig 2.4. "Diversity of digestive organs in animals - digestive vacuole-no exit; digestive sac-one exit; digestive tubes-two exits.

Chapter 3 : An Ecosystem and its structure

A - Technical Terms:

Abiotic.

Abiotic factors.

Biotic.

Biotic factors.

Ecosystem.

Ecosystem function.

Ecosystem structure.

Living system

B - Distribution of subtitles in Chapter 3:

P = page no A = text only. B = illustration % per cent

Subtitles in Chap. 3	P	A	B	A+B	A%	B%	A%+ B%
Introduction	37	1.0	-	1.0	12.5	-	12.5
Ecos. structure	38	1.25	0.45	1.7	15.63	5.63	21.26
- Biotic factors	39	0.3	-	0.3	3.75	-	3.75
- abiotic factors	40	1.85	1.3	3.15	23.13	16.25	39.3
		4.40	1.75	6.15	55.01	21.88	76.89
Summary	43	0.2	-	0.2	2.5	-	2.5
Questions & self assess.	43	0.45	-	0.45	5.63	-	2.63
Activities	44	0.5	-	0.5	6.25	-	6.25
References	44	0.2	-	0.25	3.13	-	3.13
Total	37-44	5.75	1.75	7.55	72.52	21.88	94.40

C. Details and sequence of the main concepts.

The structure of the Ecosystem.

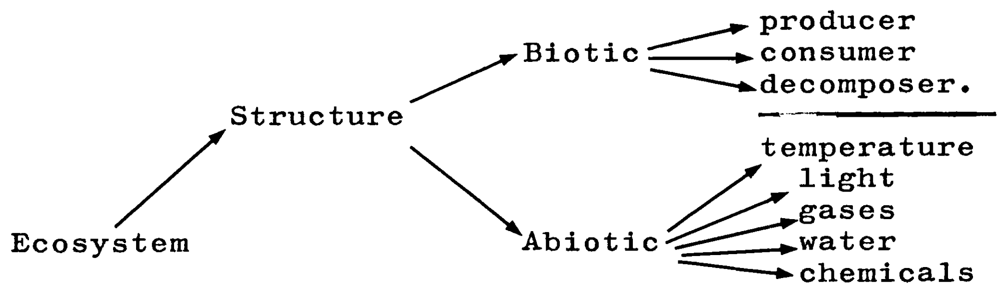
C1 Introduction: Revision of the concept of food relationships between producers and consumers and decomposers. An Ecosystem is defined as "a community of living organisms, plants or animals, interacting together and with their non-living inorganic environment.

C2 Structure of the ecosystem. Discussion of familiar examples. Biotic Factors (producers, consumers and decomposers) and Abiotic factors are introduced.

C3 Biotic Factors. Revision of previous chapters.

C4 Abiotic factors. Temperature, light, gases, water and chemicals.

D Pattern of the development of the main concepts and principles.



E Illustrations

Fig 3.1. "Structure of an Ecosystem"

Fig 3.2. "The effect on temperature on hibernation of ground squirrel"

Fig 3.3. "Smoke from factories can pollute the city"

Photograph showing smoking chimneys.

Chapter 4 : The Ecosystem and its functions.

A - Technical Terms :

Aquatic

Aquatic ecosystem

Atomic explosion

Calcium

Carbonate

Carbon cycle

Carnivore

Chemical energy

Climax

Coniferous

Coniferous forest

Ecologist

Energy conversion

Energy Flow

Food chain

Food web

Forest ecosystem

Herbivoure

Lower plants

Nutrient cycle

Nitrogene cycle

Organo-chemical cycle

Primary consumer

Pyramid of energy

Pyramid of mass

Pyramid of numbers

Pollutant

Pollution

Radiant energy

Radio active

Strontium 90

Succession

Secondary consumer

Tertiary consumer

B - Distribution of subtitles in Chapter 4

P = page no. A = Text only B = illustration % per cent

Subtitles in Chap: 4	P	A	B	A+B	A%	B%	A% +B%
Introduction	45	0.1	-	0.1	0.9	-	0.9
Energy flow	45	1.15	1.5	2.65	9.99	13.63	23.62
- Food chain & Web	48	0.35	0.9	1.15	3.18	8.63	11.81
Nutrient cycle	48	1.5	1.4	2.9	13.63	12.72	26.35
Succession	52	1.3	1.0	2.3	11.81	9.09	21.90
		4.40	4.8	8.20	39.51	44.07	84.58
Summary	54	0.25	-	0.25	4.27	-	2.27
Question & self assess.	54	0.5	-	0.5	4.54	-	4.54
References	55	0.3	-	0.3	2.72	-	2.72
Total	45-55	5.35	4.8	9.25	49.04	44.07	93.11

C Details and sequence of the main concepts and principles The functions of the Ecosys~~s~~tems.

C1 Energy Flow. The energy conversion, different types of energy and law of energy conversion are reviewed.

C2 Through the example discussed in chapter one "Energy budget". Energy conversion and energy wastage are defined.

C3 The Pyramid of Energy is discussed and is related to the Pyramid of mass and the Pyramid of Number.

C4 Food chain and Food web. The interaction of the organisms in the Pyramid of Energy is discussed by the introduction of food chain and food web.

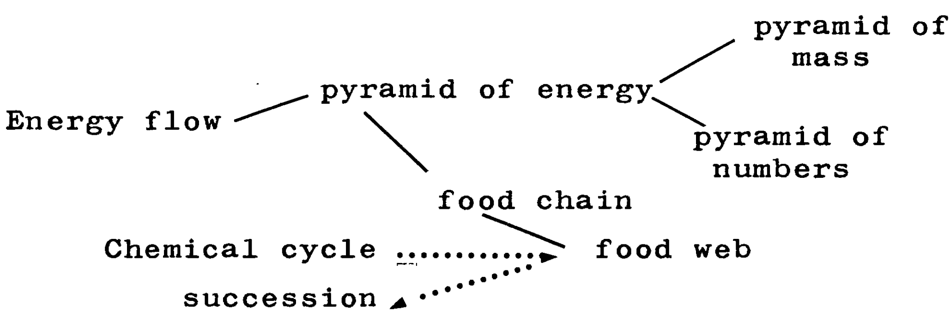
C5 Nutrient Cycle. Organic substances are mainly composed of C, N, H and O. When they are decomposed they change into CO_2 and H_2O and other nutrient products, changing in their cycle from organic to inorganic materials.

C6 Carbon Cycle. Carbon dioxide produced from respiration, decomposition of organic compounds calcarious rocks (and carbon fossils) oil and coal are used in photosynthetic green plants. It is then used for the synthesis of organic (compounds) substances which finally return to the atmosphere.

C7 The cycle of matters like Strontium 90 and D.D.T pollute the ecosystem and endanger life.

C8 Succession: Definition given as "a gradual replacement of one community by another in an ecosystem. Since this happens gradually there is a temporary stability (climax)" one example from the awuatic and terrestrial ecosystem is discussed with reference to the process of succession.

D. Pattern of the Development of the main concepts and principles



E. Illustrations

Fig 4.1. " Most of the energy is wasted in the flow of en energy from producer to a consumer"

Fig 4.2. "In the process of living activities some energy is wasted so that the amount ofenergy flow decreases from producers to the consumers" Fig. shows pyramid of energy.

Fig 4.3. "The pyramid of numbers in a Forest ecosystem" "In the pyramid of number, the numbers of organisms decrease and their size increases from the producer to the last consumer".

Fig 4.4. "A food chain".

Fig 4.5. "A food web".

Fig 4.6. "Cycle of matter in Nature".

Fig 4.6. "Cycle of Strontium 90 in Nature".

Fig 4.8. An example of terrestrial succession. Replacement of one exosystem by another ecosysmtem as a result of succession.

Chapter 5 : Population, the unit of ecosystem.

A - Technical Terms:

*Abiotic factors	Maturity
* Biotic factors	Mortality
Birth Control	Birth rate
Density	Population
Dependent factor	Population changes
Emmigrant	Population explosion
Human population	Population growth
Immigrant	Sample
Individual	Sampling
Malnutrition	Sampling techniques

B - Distribution of subtitles in Chapter 5:

P = Page No. A = Text only. B = illustration only % per cent

Subtitles in Chap: 5	P	A	B	A+B	A%	B%	A% + B%
Introduction	56	0.2	-	0.2	1.54	-	1.54
Density	56	2.8	0.8	3.6	21.56	6.16	27.72
Factors affecting pop:D	60	1.45	0.55	2.0	11.16	4.23	15.39
Population changes	62	1.25	0.40	1.65	9.62	3.08	12.70
Human population	63	2.35	1.65	4.0	18.09	12.70	30.79
		8.05	3.40	11.45	61.97	26.12	88.09
Summary	67	0.2	-	0.2	1.54	-	1.54
Questions & Self assess:	68	0.35	-	0.35	2.69	-	2.69
Activities	68	0.10	-	0.10	0.77	-	0.77
References	68	0.25	-	0.25	1.99	-	1.92
	56-68	8.95	3.4	12.35	68.89	26.12	95.05

C. Details and sequence of the main domains.

Population. The Unit of Ecosystems.

C1 Definition of population given as "a group of the same species that at a certain time live in a certain place.

C2 Population Density defined as "the number of individuals living at a time in a certain surface or volume unit of place". Population density is calculated by

$$D=\frac{N}{S}$$

Where D is density, N = numbers of individuals S = surface. In the case of airborne or aquatic floating creatures S is replaced by V = volume.

C3 "Sampling" is the scientific method for investigating population density.

C4 Factors affecting population density. Population density changes due to the effects of increasing and decreasing factors.

C5 Birth rate and immigration are increasing factors.

C6 Mortality and emmigration are decreasing factors.

C7 Biotic factors are density dependent and abiotic factors are independent from its effect of different densities.

C8 Population changes, growth and equilibrium. Population has a life span; it grows, matures and declines.

C9 The population density of the prey and predator oscillates.

C10 Abiotic factors cause abrupt changes in population density.

C11 Human population is also under the influence of density dependent and independent factors.

Food is the most important factor affecting man, but health, education, religion, housing etc., also affect population density.

Birth Control is one way of controlling population density and preventing population explosion.

D Pattern of the development of the main concepts and principles

Method of measuring sampling technique

Population Density

Density change

Human Population

Dependent factors Biotic factors

Birth rate
Mortality
Emmigrant
Immigrant

Independent Abiotic factor

E. Illustrations

Fig 5.1. "Method of collecting earthworms to determine population density.

Fig 5.2. "The hypothetical number of each sample in the school garden." A model guide to sampling technique

Fig 5.3. "Will this balloon burst?". A model showing different factors affecting population density.

Fig 5.4. "Population changes, growth and equilibrium". A graphical representation.

Fig 5.5. "Human Population growth from 3000BC - 1970AD"

Fig 5.6. "Human Population growth in some countries".

Fig 5.7. How this Population was kept at the rate of 300 persons.

Chapter 6 : Interaction in Ecosystems

A - Technical Terms:

Coleoptera	Parasite
Competition	Parasitism
Host	Peck-order
Interaction	Predation
Lepidoptera	Social parasite
Lichen	Commercialism
Mutualism	Symbiosis
	Territorial protectiveness (Territoriality)

B - Distribution of subtitles in Chapter 6:

P = page no. A = Text only. B = illustration only. % per cent

Subtitles in Chap: 6	P	A	B	A+B	A%	B%	A% + B%
Introduction	69	0.15	-	0.15	1.66	-	1.66
Competition	69	0.6	-	0.6	6.66	-	6.66
Territoriality	69	0.5	1.0	1.5	5.55	11.11	16.66
Peck-order	70	0.2	0.5	0.7	2.22	5.55	7.77
Symbosis	70	0.1	-	0.1	1.11	-	1.11
Mutualism	70	0.2	-	0.2	2.22	-	2.22
Commensalism	72	1.0	1.45	2.45	11.11	16.10	27.20
Parasitism	75	0.55	0.60	1.05	6.11	6.66	12.77
Predation & interaction	76	0.6	0.15	0.75	6.66	1.66	7.32
		3.90	3.70	7.60	43.3	41.08	84.38
Summary	77	0.1	-	0.1	1.11	-	1.11
Questions	77	0.4	-	0.4	4.44	-	4.44
Activities	-	-	-	-	-	-	-
References	77	0.45	-	0.45	4.99	-	4.99
Total	69-77	4.85	3.70	7.65	53.94	41.08	94.92

C. Details of main domains and principles.

Interaction in Ecosystems.

C1 Competition. Defined as "if two different populations require a common resource such as nutrient, space ro light, which is particularly limited, they are said to be in competition for it.

C2 Territorial protectivenss which is carried out by the application of visual or other signals is a kind of competitiveness, eg. peck order.

C3 Discussion of interaction between two organisms. Commensialism is an association where only one partner benefits, the other neither benefits or loses. Symbiosis - both partners benefit from each other. Parasitism - only one partner benefits while the other loses.

C4 Predation: An interaction between two organisms The pollution of prey and predator fluctuate proportionally.

D. Pattern of the Development of the main concepts and principles

- Interaction → Territoriality
- Interaction → Peck order
- Interaction → Symbiosis
  - Symbiosis → Mutualism
  - Symbiosis → Commensalism
  - Symbiosis → Parasitism
- Interaction → Predation

E. Illustrations.

Fig 6.1. "Territorial protectiveness in Rabbits is by smelling signals".

Fig 6.2. "Peck order in the chicken population demonstrates social order".

Fig 6.3. "Some examples of symbiosis between insects and fungi."

Fig 6.4. "A complex symbiotic organism in the termite intestine."

Fig 6.5. "Cuckoo's egg pattern resembles the host's egg."

Fig 6.6. "Predatory relationships between some living creatures in a food chain".

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Chapter 7 : Aquatic Ecosystems

A - Technical Terms:

*Aquatic

*Aquatic ecosystems

Chemical

Light

Marine consumers

Marine decomposers

Marine ecosystems

Marine producers

Soluble gases

Salinity

Temperature

Zooplankton

Fresh-water ecosystems.

B - Distribution of subtitles in Chapter 7.

P = page no. A = text only. B = illustration only. % per cent.

Subtitles in Chap: 7	P	A	B	A+B	A%	B%	A%+ B%
Introduction	78	0.1	-	0.1	1.66	-	1.66
Some general characteristics of the aquatic ecosysstem	78	1.4	-	1.4	23.32	-	23.32
Marine ecosystem	79	0.55	0.8	1.35	9.16	13.32	22.48
Fresh-water ecosystem	81	0.6	-	0.5	8.33	-	8.33
Man and aquatic ecos:	81	0.5	-	0.5	8.33	-	8.33
		3.05	0.8	3.85	50.70	13.32	64.12
Summary	82	0.2	-	0.2	3.33	-	3.33
Questions & self assess:	82	0.5	0.15	0.65	8.33	2.49	10.82
Activites	83	0.05	-	0.05	0.83	-	0.83
References	83	0.45	-	0.45	7.49	-	7.49
Total	78-83	4.25	0.95	5.20	70.68	15.81	86.49

C. Details and sequence of the main concepts and principles.

Aquatic Ecosystems.

C1 Aquatic ecosystems have similar structure and function to other ecosystems.

C2 Certain factors: temperature, light, water, soluble gases and chemicals affect biotic factors in the aquatic ecosystem.

C3 The main variations between freshwater and brine ecosystems are due to the different amounts of chemicals in and salinity of the water.

Marine ecosystem.

C4 The main producers of the aquatic ecosystem are microscopic algae called phytoplanktons. These photosynthetic organisms are limited to the surface where light can penetrate.

C5 The primary aquatic consumers are small and mainly consist of crustacea and are called zooplankton. These are also bound to the surface since they feed on the producers in the same zone.

C6 The other large animals of aquatic ecosystems are secondary, tertiary, etc., consumers.

C7 Freshwater Ecosystem.

Streams, ganats (underground channels) river, lake and spring are examples of freshwater ecosystems.

C8 Structure and function of the freshwater ecosystem is similar to that of the sea ecosystem.

C9 Man and the aquatic environment. Man's activities such as the use of rivers and lakes for navigation and disposal of waste materials, pollute aquatic ecosystems. In the Persian Gulf, oil is the main pollutant.

D. Pattern of the development of the main concepts and principles.

Characteristics

Terrestrial Ecosystem

Marine Ecosystems → (Biotic factors / Abiotic factors)

Freshwater Ecosystem → (Biotic factors / Abiotic factors)

E. Illustrations

Fig 7.1. "Some kinds of phytoplanktons".

Fig 7.2. " Some kinds of zooplankton".

Chapter 8: Terrestrial Ecosystems.

A - Technical Terms:

Adaptation

Canopy

Coniferous forest

Crossed-bill bird

Deciduous forest

Desert

Equator

Grass-land

Hybernation

Taiga

Tropical forest

Tropical rain forest

Tundra

Winged seed.

B. Distribution of subtitles in Chapter 8:

P = page no. A = Text only B = illustration on % per cent

Subtitles in Chap: 8	P	A	B	A+B	A%	B%	A% +B%
Introduction	84	0.2	-	0.2	1.58	-	1.58
Tundra	84	0.2	0.95	1.45	8.84	7.30	11.14
Coniferous forest	86	0.55	0.7	1.25	4.22	5.38	9.60
Deciduous forest	87	0.9	0.6	1.4	6.92	4.61	11.53
Tropical forest	89	0.8	0.6	1.4	6.15	4.61	10.76
Grass-land	90	0.3	0.25	0.55	2.3	1.9	4.2
Desert	91	0.55	0.85	1.7	4.22	9.61	13.83
Man & Terrestrial ecos.	92	1.45	1.0	2.45	11.15	6.53	17.68
		5.25	4.95	10.20	39.38	40.94	79.32
Summary	95	0.3	-	0.3	2.3	-	2.3
Questions & self assess.	95	0.45	-	0.45	3.45	-	3.45
Activities	96	0.15	-	0.15	1.14	-	1.14
References	96	0.40	-	0.4	3.07	-	3.07
Total	84-96	7.15	4.95	12.10	48.34	40.94	99.38

C. Details and sequence of the main concepts and principles.

Terrestrial Ecosystems.

C1 Terrestrial Ecosystems are more varied than aquatic ecosystems.

C2 Tundra is characterized by a short spring season, very few organisms can exist in this ecosystem. Most of the animals hibernate.

C3 Coniferous Forest is characterized by low temperatures and rate of precipitation, with evergreen plants. It has a varied wild life.

C4 Deciduous Forest is characterized by moderate temperatures and rate of precipitation. It has regular seasons and in the Autumn the trees loose their leaves.
In Iran the Alborg and Zagros mountain ranges are partly covered by this type of forest.

C5 Tropical Forest is characterized by a continuous high temperature and rate of precipitation. There is high growth of producers and large bodied consumers.

C6 Grassland is characterized by variable temperature and moderate irregular precipitation. Animals are runners and diggers. The producers are main herbacious.

C7 Desert is characterized by high day temperature and low night temperature. There is a low rate of precipitation. Plants produce enormous root systems but few branches. Animals are nocturnal.

C8 Man and Terrestrial Ecosystems. Mans activities introduce artificial succession and exploit terrestrial ecosystems with various pollutants.

E. Illustrations

Fig 8.1. The yearly rainfall and temperature change in Tundra, represented by two graphs.

Fig 8.2. "Some representative animals of Tundra - Polar bear, Rabbit, Polar Fox.

Fig 8.3. "The yearly rainfall and temperature change in Taiga".

Fig 8.4. "Coniferous Forest".

Fig 8.5. "The yearly rainfall and temperature change in a Deciduous forest".

Fig 8.6. "Some part of the Carprinus forest band in Alborz mountains".

Fig 8.7. "The annual rainfall and temperature change in a Tropical forest".

Fig. 8.8. "The annual rainfall and temperature change in grass-land".

Fig 8.9. "The annual rainfall and temperature change in a desert".

Fig 8.10. "Desert ecosystem".

Fig 8.11. "Distribution of different ecosystems on the earth".

APPENDIX 4

CHANGES IN THE BIOLOGY TEXTBOOK SINCE 1974

Changes in the Biology Textbook since 1974

Introduction: The Book Organisation at the Ministry of Education is responsible for the development of the textbooks required for each grade in Iranian Schools. At this organisation there are usualy two types of editors who are involved in the preparation of a specialised textbook:

i) The specialised editor who works closely with the author, and is also responsible for the revision of the textbook.(ii) The literary editor who makes sure that all the linguistic aspects of the text are in line with that of other books. The textbook author is usually selected by the Book Organisation on the basis of recommendations received from the specialised Editor. He is usually selected from teachers or from university lecturer' in the required specialised subjects.

When the author has accepted the invitation to write a textbook, he signs a contract with the Book Organisation whereby he sells his copyright, on a permanent basis for a fixed amount of money, to the Ministry of Education. This copyright fee is the same for all textbooks, although it may be altered slightly, if the editor recommends, or is the number of pages and amount of work required for the completion of the book is exceptionally high. In theory, according to the contract details the author of each textbook is responsible for its revision every year. In practice, since no fund is allocated for this service, the job is usually left to the editor, whose official career is concerned with the revision and editing of textbooks, according to the needs and requirements of the system. In the case of the Biology Curriculum, there were two authors involved in the preparation of the textbook. One author, H. Daneshfar, was a Biology teacher, who was also working as an expert at the Curriculum Planning and Research Centre, and the second joint writer, J. Hashemi, a lecturer in Biology Methods at the Faculty of Education, Tehran University.

In 1975, Daneshfar became Biology Editor for the Book Organisation. His new job provided a unique capacity for him, therefore, to implement a) the results of his experiences in teaching the Biology Curriculum, and b) the criticisms and suggestions of other Biology teachers in the In-Service courses and c) the results of the Pilot Study carried out by Hashemi in 1975, in the revision of the later editions of the textbook.

Because of these changes, the 1976 editions of the textbook differed so much from all earlier versions. In the following paragraphs, details of the 1974 and 1976 editions are compared with those of the 1974 printing. Details of the 1975 edition can be found in Appendix III of the present thesis.

General Views on the Revision of the Biology Textbook.

In the 1974 printing the contents of the Biology Textbook were divided into two separate sections : a) Section One; Ecology and b) Section Two : Hygiene. The present study is concerned with only the 1st Section; Ecology. In the 1974 print the Ecology Section consisted of an Introduction and Eight Chapters. This pattern and sequence was maintained

In the 1975 edition. However in the 1976 edition the Introduction was integrated with Chapter 4 on the theme of "Interaction within Ecosystems and a new sequence of chapters was implemented (Table I).

In Table I the general changes introduced in 1975 and 1976 editions are compared with those of the 1974 printing.

Table I The general Comparision between topics in the different Biology Textbook editions.

1974 and 1975 Editions	1976 Edition
Introduction:The Web of Life	Integrated with Chapter 4
Chapter 1 Autotrophism	The Web of Life
Chapter 2 Heterotrophism	Population
Chapter 3 Structure of an Ecosystem	Interaction
Chapter 4 Function of an Ecosystem	Structure of an Ecosystem
Chapter 5 Population	Producers and Consumers
Chapter 6 Interaction	Aquatic Ecosystem
Chapter 7 Aquatic Ecosystems	Terrestrial Ecosystem
Chapter 8 Terrestrial Ecosystems	Man and the Changes in the Ecosystem

A detailed comparison of the Different Editions of the Biology Textbook:

For details of the 1975 edition see Appendix III Curriculum Content Analysis. In following paragraphs, details of 1975 and 1976 editions are compared with those of 1974 edition.

A. In 1975 Edition minor revisions implemented in contents:-

A - 1.0 Introduction of a pink colour printing in text and come figures to emphasise main points.

A1.1 Introduction: Subject of ATP and ADP omitted

Fig I and II replaced by 2 simplified versions.

A.1.2. Chapter 1. Process of Photosynthesis simplified and revised, eg. effects of colour of light omitted + its respective graph.

Discussion of ATP and ADP eliminated.

Experiment on Absorbtion of CO_2 by green plants (Appendix III, p11, C.3) - bicarbonate indicator replaced by Bromo-thymol Blue.

A.1.3. Chapter 2. Mostly revision or omission of figures eg. Fig 2-1.

"Percentage of Materials in the Body" omitted.

Diagram 2-3 replaced by simplified one.

Diagram 2-6 showing sequence in the Process of feeding in Starfish was replaced by Fig 2-4 (Appendix III, p18) showing various structures of Digestive Organism in the Animal kingdom.

A.1.4. Chapter 3. Experiment about the effect of Smoke on Air Pollution transferred from text to "Activities outside the classroom", section of the same chapter.

A.1.5. Chapter 4. Most changes concerned with simplification of figures, and omission of un-necessary and less comprehensible ones eg. Fig 4. 6-a+b replaced by more simple figures;

Fig 4-8 showing eg of Terrestrial Succession replaced by more detailed version;

Fig 4-6-c omitted.

A.1.6. Chapter 5. New topic introduced. "The Problem of Human Population".

A.1.7.Chapter 6.No change.

Chapter 7 No change.

Chapter 8 No change

B. In the 1976 edition many changes in the contents and layout of the textbook, as well as the sequence of chapters and topics were introduced.

B.1.0.The pink colour print of the text and figures was replaced by blue colour print.

An improved and more comprehensible layout throughout the book.

B.1.1.Contents of "Introduction" integrate with Chapter 4.

Latin terms of Autotrophism and Heterotrophism omitted.

B.1.2.Chapter 2 (Appendix III Chapter 5) Topic of Human Population removed. Re-introduced in last chapter on subject of "Man and Changes of Ecosystems".

B.1.3.Chapter 3.Topic of "Peck Order" omitted.

B.1.4.Chapter 4.As previous versions.

B.1.5.Chapter 5.Combination of Chapter 1 and 2 of previous versions. Sequence of concepts maintained.

B.1.6.Chapter 6. As previous versions.

Chapter 7. As previous versions.

B.1.7.Chapter 8.A new chapter on "Man and the Changes in Ecosystems". This topic was an integration of various topics in Chapter 4 "Function of the Ecosystem", and Chapter 5 "Population" with a new approach to the subject of Pollution discussed in previous chapters.

The objective of this chapter is threefold:-

a) To implement the recent revisions of the new system of education which emphasises environmental studies.

b) To relate the concept and principles introduced in the previous chapters with the topics of Man and his effect on Ecosystem (Specific Goal No.2 Appendix II, p4).

c) To show some applications of the subject in everyday life (Goal No.2. Appendix II, p2).

Discussion and Conclusions.

The Curriculum content analysis was carried out on the basis of the 1975 edition of the Biology textbook. The content of this edition was nearly the same as that in the 1974 print. Some changes were introduced however and some figures were altered.

In 1976 edition, the sequence of some of the concepts and principles was altered eg. the study of the details of the process of consumption and production of the organic materials in the Web of Life was postponed until the middle of the term. This change did not affect the integrity and general understanding of the concepts and principles of ecology as a whole as advised in the Biology Curriculum content, but provided a new sequence in the contents that facilitated pupils learning.

APPENDIX 5

THE BIOLOGY TESTS-PILOT AND EXPERIMENTAL VERSIONS

Class ....

School ....   Starting time ....

City ....   Finishing time ....

Age ....

The Biology Test

Dear Student,

This test has been developed in order to investigate any problems created by the implementation of the new Biology Curriculum in the first year of the secondary education throughout the country. The objective of this test is to pin-point any area in the curriculum where the learner, such as yourself, may have found difficulties. These difficulties may have arisen from ambiguity of the topic from part of the text.

Since all members of the class may have found difficulties in various topics, pin-pointing these difficulties can identify individual and group difficulties that have been created from the implementation of the new Biology Curriculum and its textbook.

This investigation cannot be performed without your complete co-operation. If you consult other students during the testing procedure, their knowledge and difficulties will distort your answers. Since the answer sheet is anonymous, please answer the test with accuracy and honesty.

All the questions can be answered by writing either a single word or a sentence.

Example 1 - one word:

If the sunlight beams on a piece of glass it will warm it. In this example, the light energy has been converted into .... energy. Answer: thermal.

Example 2 - one word:

Which vital phenomenon is the reverse, in terms of chemical reaction, to photosynthesis? Answer: respiration.

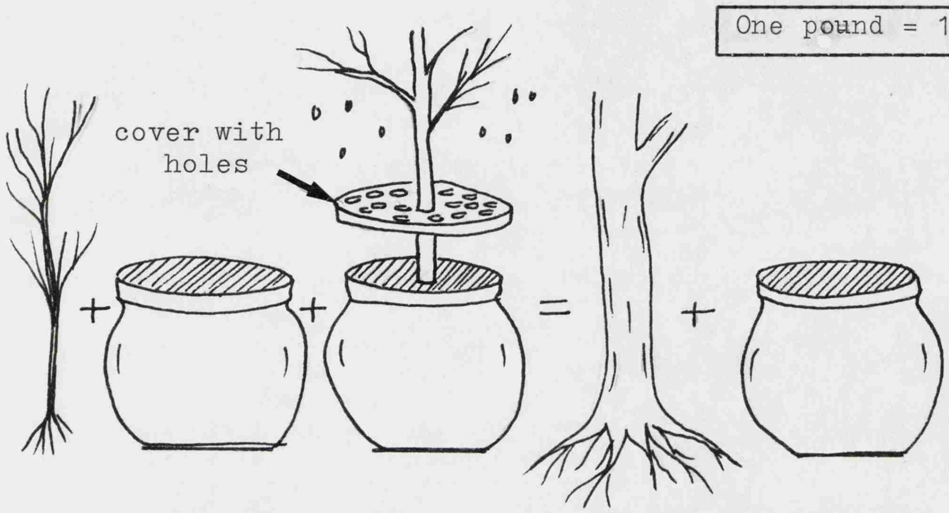
Example 3 - one sentence:

How do you prove the existence of starch in an organic substance? Answer: by adding some iodine solution to show a blue or purple colour is produced.

Please do not start until the "start" announcement.

In the following diagram a summary of Van Helmont's experiment is shown. Answer the following questions by using this summary and what you have already learnt.

One pound = 16 ounces



5 lb shoot + 200 lb dry soil + 5 years with only a supply of rain water or distilled water = 169 lb 3 oz Tree + 199 lb 14 oz dry soil

1. According to Van Helmont the 164 lbs of the matter in the plant came:

   a) Entirely from the earth in the pot.

   *b) Entirely from water provided to the plant.

   c) From both the earth in the pot and the water provided.

   d) From matter in the air which entered the plant.

   e) From matter dissolved in the water provided to the plant.

2. Van Helmont probably assumed all the following except:

   a) Air in the atmosphere contains a considerable amount of dust.

   b) Matter is neither created nor destroyed.

   *c) Gases in the atmosphere are a source of matter for the plant.

   d) Rain water contains no dissolved material.

   e) The leaves produced had appreciable weight.

3. Van Helmont would probably have realised that his conclusion was wrong, if he had:

*a) Measured the weight of water given off by the plant.

b) Determined the weight of the pot used in the experiment.

c) More accurately weighed the tree at the beginning and end of the experiment.

d) Not provided water to the tree in addition to rain water.

e) Weighed the leaves produced in the four autumns.

4. Which of the following conclusions could summarise better Van Helmont's experiment?

a) Green plant growth is entirely possible by absorbing water.

b) Plant growth is entirely possible by absorbing gases in the atmosphere.

c) Plant growth depends on the absorption of water and minerals.

d) Plant growth is possible if it only absorbs rain water and distilled water.

*e) Plant growth is possible by absorbing water minerals and gases.

1) Which word means the same as "heterotroph"? ....

2) Define the word "producer". ....

....

3) How do you prove the existence of starch in food materials?

....

4) In which ecosystem do trees lose their leaves in autumn?

....

5) In your opinion, what kind of organism is the honey bee? A producer or a consumer? ....

6) In some of the cold winters wild animals migrate to villages and cities and their population density increases in these environments. What kind of factors cause the migration of these animals? ....

....

7) What formula do you use to calculate the population density of trees in a pine forest? ....

8) Which relationship is shown in the following diagram?

Producer ⟶ Herbivours ⟶ Carnivours

....

9) In a closed room where sunlight enters through its windows, there are some geranium plants.

a) In the daytime, what effect has the geranium on the composition of the air in this room? ....

....

b) In the night-time, what change takes place in the air composition? ....

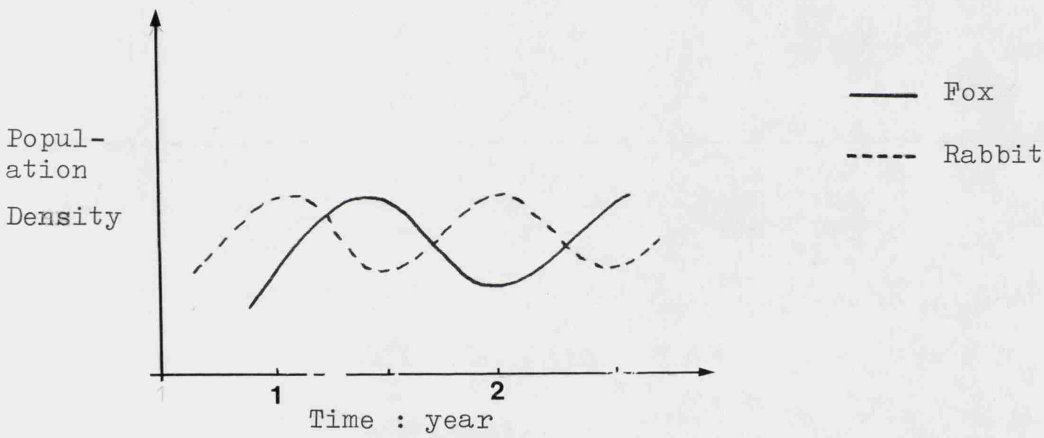
....

10) When Karadj Dam was built, water was accummulated behind the dam. Many of the local animals were either destroyed or migrated to other localities. All the plants were destroyed. After some time, due to the migration of river organisms, a lake ecosystem was created. Which term can describe the change in the ecosystem that took place? ....

11) Define the word "parasite". ....

....

12) The following graph represents yearly change of the fox and rabbit population density in a grassland area.

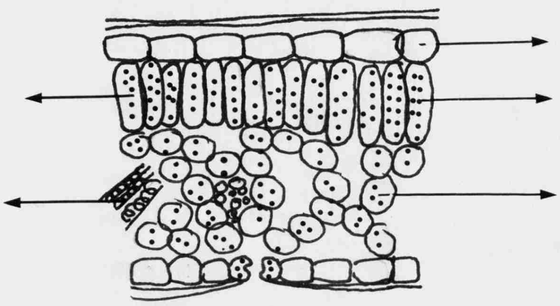


What relationship is probably responsible for population fluctuation?

....

13) In which part of the green plant are the organic materials digested? ....

14) In the following diagram the internal structure of a dicotyledon leaf is shown in transection. Name each part and write it against the appropriate place in the diagram.



15) Name the molecules which result from the digestion of protein, carbohydrate and fat molecules.

a) Protein .... b) Carbohydrate ....

c) Fat ....

16) There were some local plants and animals in the desert around the town called Sabzevar. Since the creation of artificial forests there 1) the population density of animals increased, 2) many new animal species have appeared, 3) some of the local species disappeared. Name the factors which might have caused population changes for items 1 to 3 above.

1) ....

2) ....

3) ....

17) What type of relationship in human population is shown by man in building walls around houses? ....

Class .... Starting time ....

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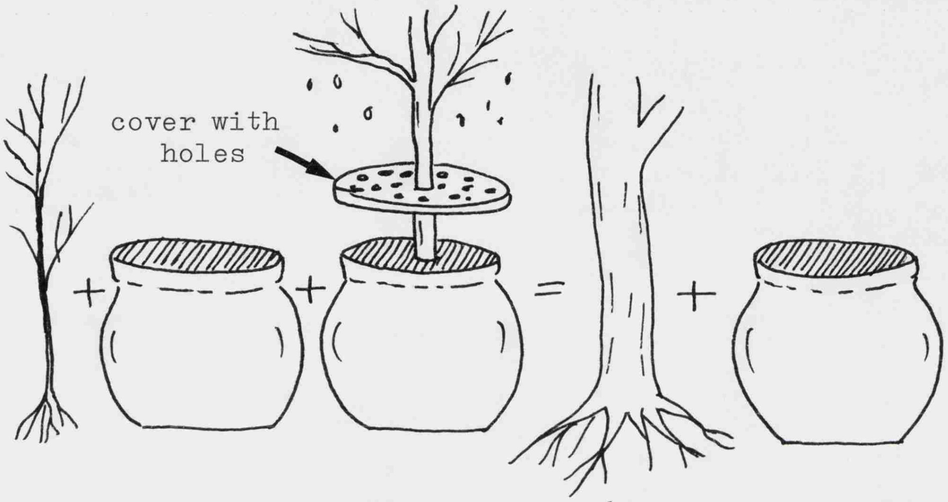

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d) Plant growth is possible if it only absorbs rain water and distilled water.

*e) Plant growth is possible by absorbing water minerals and gases.

1) In this sentence "Foxes feed on rabbits" the rabbit is a kind of .... for the fox.

2) Name two different kinds of autotrophic organisms.

.... and ....

3) Write down the name of the green pigment of plants. ....

4) Which is the best method to estimate the number of fish population in a lake? ....

5) In which terrestrial ecosystem does one find varieties of succulent and spiny plants? ....

6) Define the law of conservation of energy. ....

....

7) Name the molecule which results from the digestion of the proteins. ....

8) What factor interrelates the food chains and produces a food web in an ecosystem? ....

9) What kind of relationship exists here? "In tropical forests, one sometimes finds birds plucking and eating parasites from the skin of large mammals." ....

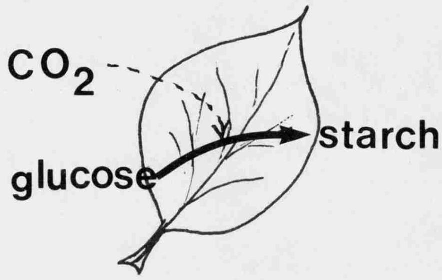
10) Javad is called a "primary consumer" when he eats lettuce. What is he called when he eats egg? ....

11) Which kind of ecosystem is described here? "The area is covered by trees. In their canopies there are varieties of animals such as the owl, snake and insects. The body size of animals in this area is relatively large." ....

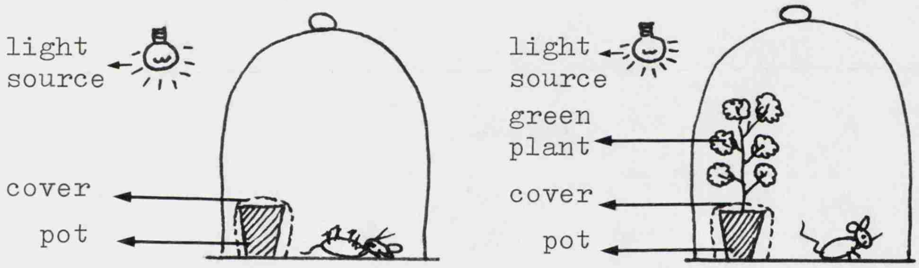
12) Why are organic materials not consumable, as they have been taken, by heterotrophs? ....

....

13) What stage of photosynthesis is represented by the following diagram? ....



14) In the following experiment there were identical conditions in the two jars when it was set up. A green plant was then placed under jar B.



a) Describe the reason why the mouse under jar A died.

....

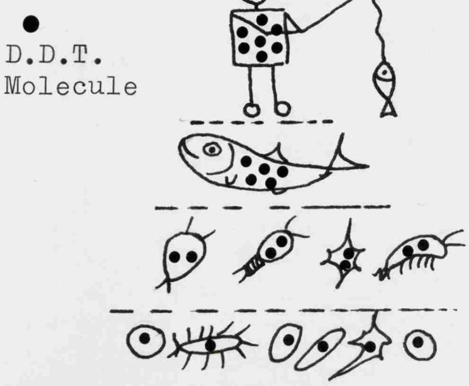
....

b) Describe the reason why the mouse under jar B has survived.

....

....

15) In the following food chain the concentration of D.D.T. has increased in the body of the fisherman. Describe what biological principal has caused this phenomenon.



....

....

....

....

....

16) What is the meaning of food in the following sentence? "Producers are able to make their food from inorganic materials."

....

....

17) What is the function of decomposers in an ecosystem? ....

....

....

UNIVERSITY OF BATH

SCHOOL OF EDUCATION

B I O L O G Y   T E S T   B O O K L E T

FOR FIRST YEAR STUDENTS

OF SECONDARY SCHOOLS

FORM A

AUTHOR

JAVAD HASHEMI TAFRESHI

March 1976

DIRECTIONS FOR ANSWERING BIOLOGY TEST ITEMS

Dear Student,

This test has been developed to investigate the way in which the new Biology Curriculum in the first year of secondary education is proceeding. The objective is to pin-point any area of the curriculum where the learner, such as yourself, may find difficulties. Difficulties may have arisen from ambiguous ideas that you found in the textbook, or in the instruction, or elsewhere.

Since such an investigation cannot be performed without your complete cooperation, please do not consult the person sitting next to you when answering questions, as this will affect the result of your test and makes it difficult to differe~~n~~tciate your personal difficulties from his.

The answer sheet is anonymous. Therefore answer the questions with accuracy and honesty. If, however, you do not know the answer to any particular question, leave the corresponding space on the answer sheet blank.

Most of the questions are multiple-choice questions and only one of the choices is the right answer to that particular question. Normally the right answer is randomly distributed and does not follow any regular pattern in their arrangements. Therefore, if you simply cross all the "D's" on the answer sheet, this does not provide a good test result. The same rule applies to guessing the right answer when you don't know it. Please read each question carefully and only when you are sure that you know the right answer, cross the corresponding place on the answer sheet accompanied with this booklet. Make sure your answer sheet and the booklet both have the same code of "A" or "B". The following examples may clarify the procedure:

In this test there are two types of questions:

1) Multiple-choice questions:

Example: If the sunlight beams on a piece of glass it will warm it. In this example light energy has been converted into .... energy.

a) Mechanical

b) Chemical

*c) Thermal

d) Atomic

e) Light

The answer to question 1 is "thermal". Look at the answer sheet, on the top of the page, against the sample question 1, the category "c" is crossed for the right answer to this question.

2) Short answer questions:

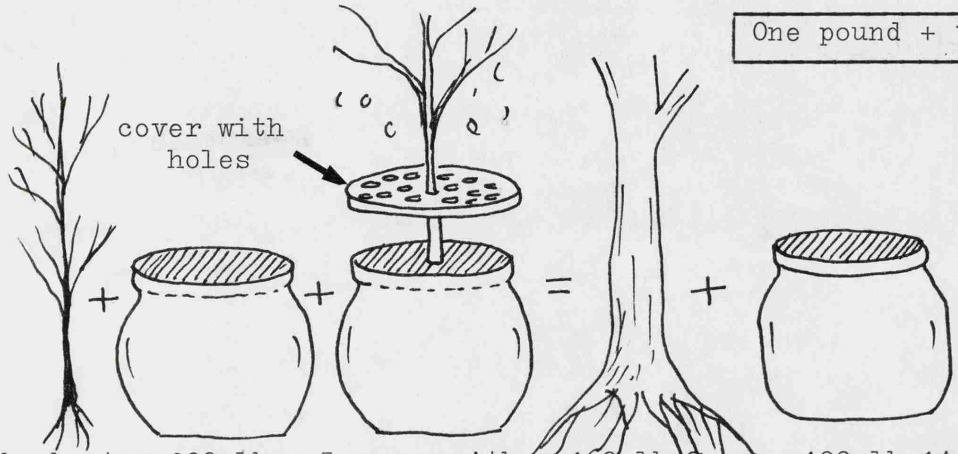
Example: Name two desert animals and write them on the space provided on the answer sheet.

If you look at the answer sheet, you will find two words "scorpion" and "desert rat" have been written in front of the sample question 2.

(Do not write anything on this booklet.)

Questions 1 - 4: In the following diagram a summary of Van Helmont's experiment is shown. Answer the following questions by using this summary and what you have already learnt.

One pound + 16 ounces



5 lb shoot + 200 lb dry soil + 5 years with only a supply of rain water for growth + 169 lb 3 oz tree + 199 lb 14 oz dry soil

1) According to Van Helmont, the extra 164 lbs of the matter in the plant came:

a) Entirely from the earth in the pot.

*b) Entirely from water provided to the plant.

c) From both the earth in the pot and the water provided.

d) From matter in the air which entered the plant.

e) From matter dissolved in the water provided to the plant.

2) Van Helmont probably would have concluded differently from his experiment had he known that:

a) Air in the atmosphere contains a considerable amount of dust.

b) Matter is neither created nor destroyed.

*c) Gases in the atmosphere are a source of matter for the plant.

d) Rain water contains no dissolved material.

e) The leaves produced had appreciable weight.

3) Van Helmont would probably have realised that his conclusion was wrong, if he had:

*a) Measured the weight of water given off by the plant.

b) Determined the weight of the pot used in the experiment.

c) More accurately weighed the tree at the beginning and end of the experiment.

d) Watered the tree only with rain water.

e) Weighed the leaves produced.

4) Which of the following conclusions could summarize better Van Helmont's experiment?

a) Plant growth is entirely possible by absorbing water.

b) Plant growth is entirely possible by absorbing gases in the atmosphere.

c) Plant growth depends on the absorption of water and minerals.

d) Plant growth is possible if it is only provided with rain water and distilled water.

*e) Plant growth is possible by absorbing water, minerals and gases.

5) In what part of the green plant are the organic materials digested? Choose the best answer.

a) Root.

b) Stem.

*c) Inside cells.

d) Leaf.

e) Green plants cannot digest organic materials.

6) Which of the following materials is the name of the green pigment in photosynthetic plants?

a) Starch

b) Cuticle

*c) Chlorophyl

d) Placelets

e) Organic materials

7) Which of the following organisms are "producers"?

a) Zooplanktons

b) Bread-moulds

*c) Sulphur bacteria

d) Honey bees

e) Shrimps

8) Which one of the following phenomenon may cause inter-relationship amongst several food chains and create a food web?

a) Chemical cycle in an ecosystem.

*b) The consumption of varieties of food sources by one consumer.

c) Competition amongst producers.

d) The high population density of living organisms.

e) The consumption of varieties of producers by consumers.

9) In which of the terrestrial ecosystems may one find the following characteristics: "The area is covered by trees. In their canopies, there are varieties of animals such as owls, snakes and various kinds of insects. The body size of these animals in this area is proportionally large."

a) Tundra

b) Coniferous forests

c) Temporate forests

*d) Tropical forests

e) Deserts

10) Which one of the following materials is the structural unit of carbohydrate molecules?

a) Amino acids

*b) Simple sugars

c) Fatty acids and glycerols

d) Enzymes

e) None of them

11) The following graph represents yearly changes in the fox and rabbit population density in a grassland area. What kind of relationship, between these two organisms, is probably responsible for population fluctuation?

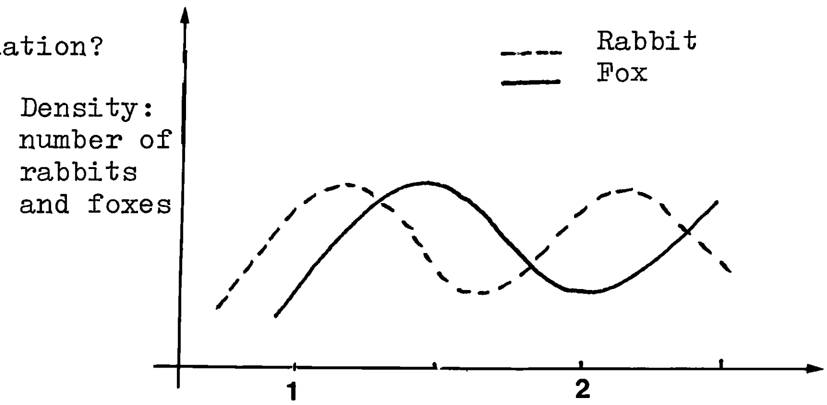
a) Food chain

b) Mutualism

c) Commensalism

d) Competition

*e) Predation



Questions 12 - 13: In a well lit greenhouse, we have kept some green plants (such as geraniums). If there is no air interchange between the greenhouse and outside, and no other living organism lives in this greenhouse:

12) In the day-time, what changes take place in the air composition?

a) The amount of CO_2 increases and O_2 decreases.

*b) The amount of CO_2 decreases and O_2 increases.

c) The amount of CO_2 and O_2 increases.

d) The amount of CO_2 and O_2 decreases.

e) The amount of CO_2 and O_2 does not change.

13) In the night-time, what changes take place in the air compositon?

*a) The amount of CO_2 increases and O_2 decreases.

b) The amount of CO_2 decreases and O_2 increases.

c) The amount of CO_2 and O_2 increases.

d) The amount of CO_2 and O_2 decreases.

e) The amount of CO_2 and O_2 does not change.

14) There were some local desert plants and animals in the desert around the town called Sabzevar. Since the creation of the artificial forest there, many new animals have appeared. They have stayed and their numbers increased. What kind of factors were responsible for this population increase?

a) Abiotic factors

b) Successions

*c) Biotic factors

d) Competitions

e) Symbiosis

15) Which one of the following materials is the starch indicator?

a) Alcohol

b) Chlorophyl

*c) Iodine solution

d) Thymol blue

e) Glycerol

16) In which kind of terrestrial ecosystem do trees lose their leaves in autumn?

a) Taiga

*b) Temporate forests

c) Tropical forests

d) Terrestrial ecosystems

e) Coniferous forests

17) Which one of the following formulae is used for calculating population density?

*a) N/S

b) S/N

c) N/D

d) SXN

e) D/N

18) What relationship is symbolised by the wall that people build around their houses?

a) Commensalism

*b) Territoriality

c) Mutualism

d) Symbiosis

e) Deck order

19) Which one of the following molecules is the structural unit of fats?

a) Amino acids

b) Enzymes

c) Amylases

*d) Fatty acids and glycerols

e) Simple sugars

20) Name two different examples of "consumers" and write them in the appropriate places on the answer sheet.

21) In this sentence "Producers are able to make their food" which of the following words can replace the word "food".

a) Photosynthesis

b) Minerals

c) Glucose

*d) Organic materials

e) Basic materials

22) Which stage of photosynthesis is represented by the following diagram?

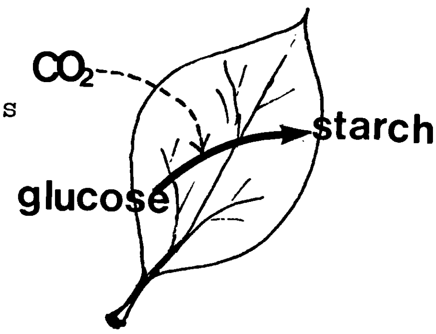
*a) Dark reactions

b) Production of inorganic materials

c) Light reactions

d) Glucose formation

e) CO_2 absorption



23) Which one of the following sentences describes best the role of "decomposer" in an ecosystem?

a) Decomposition of minerals and release of energy.

*b) Conversion of organic materials into inorganic materials.

c) Participation in Carbon and Nitrogen Cycle.

d) Consumption of organic materials.

e) Absorption of CO_2 and release of O_2.

UNIVERSITY OF BATH

SCHOOL OF EDUCATION

B I O L O G Y T E S T B O O K L E T

FOR FIRST YEAR STUDENTS

OF SECONDARY SCHOOLS

FORM B

AUTHOR

JAVAD HASHEMI TAFRESHI

March 1976

DIRECTIONS FOR ANSWERING BIOLOGY TEST ITEMS

Dear Student,

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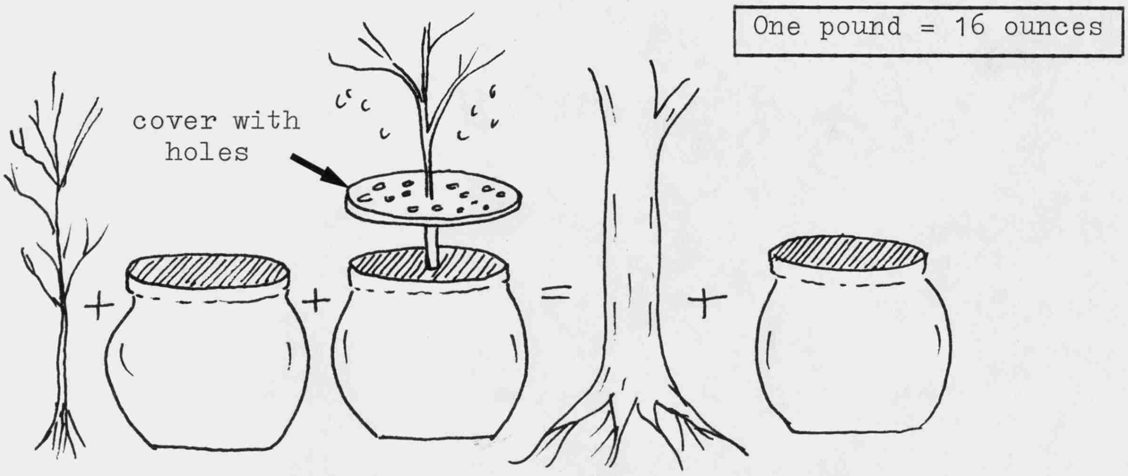

5 lb shoot + 200 lb dry soil + 5 years with only a supply of rain water for growth = 169 lb 3 oz tree + 199 lb 14 oz dry soil

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5) In what part of the green plant are the organic materials digested? Choose the best answer.

a) Root.

b) Stem.

*c) Inside cells.

d) Leaf.

e) Green plants cannot digest organic materials.

6) What type of organisms are honey bees?

a) Producers

*b) Consumers

c) Producers and consumers

d) Decomposers

e) None of them

7) What relationship is represented by the following diagram?

Producers $\longrightarrow$ Herbivores $\longrightarrow$ Carnivores

a) Symbiosis

b) Nutrient cycle

c) Food web

*d) Food chain

8) In some of the cold winters, many wild animals migrate to towns and villages where their population density increases. What is the main cause of this population increase?

a) Migration

*b) Food

c) Cold weather

d) Reproduction

e) Mortality

9) When Karadj Dam was built water was accumulated behind the dam and many of the local animals were either destroyed or migrated to other localities. Terrestrial plants were destroyed by the accumulated water. After some period of time, the number of aquatic plants and animals increased in the lake behind Karady Dam. What is the name given to the change of ecosystem that took place?

a) Migration

b) Competition

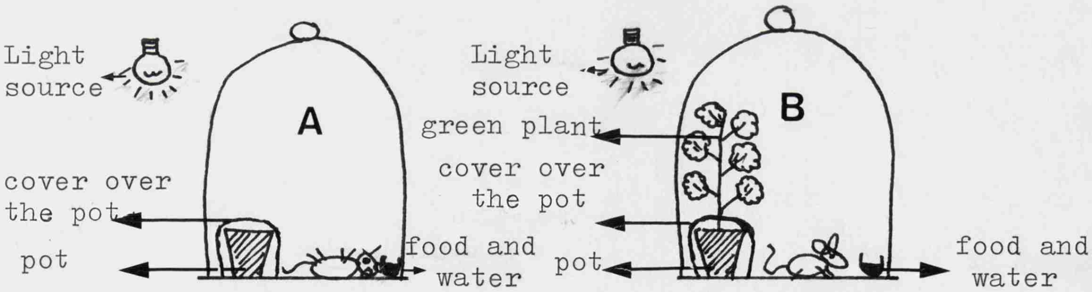
c) Interaction

*d) Succession

e) Ecosystem

10) Name two different examples of the kinds of living organisms called "producers" and write them on the answer sheet in the spaces provided.

Questions 11 -12: In the following experiment there were identical conditions in the two jars when it was set up. A green plant was then placed under jar B. After a short period of time the mouse under jar A dies but the mouse under jar B survives for a long time.



11) Which of the following statements best explains the death of the mouse in jar A?

a) The cover on the pot prevented oxygen diffusion.

b) Light does not penetrate jar A and the mouse's respiration stops.

*c) The mouse consumed the available oxygen and suffocated.

d) The light intensity in jar A is so low that it stops the plant photosynthesis.

e) The cover over the pot prevented plant respiration. Hence the mouse died due to lack of oxygen.

12) Which one of the following statements best explains the mouse's survival in jar B?

a) The green plant had some reserved air in its leaves.

b) The mouse breathed in CO_2 released by the green plant.

c) The cover on the pot prevented the green plant from absorbing CO_2 and releasing O_2.

*d) The green plant consumed CO_2 released by the mouse and released O_2.

e) The green plant released CO_2 as a result of photosynthesis.

13) What kind of "interaction" exists here? "In tropical forests, one sometimes finds birds plucking and eating parasites from the skin of large mammals."

*a) Mutualism

b) Parasitism

c) Commensalism

d) Symbiosis

e) Predation

14) The following diagram represents a food chain. In this food chain D.D.T. density has been increased, from producers to the consumer, in the body of the living organisms consecutively. Which of the following principles describes best the occurence of this phenomenon?

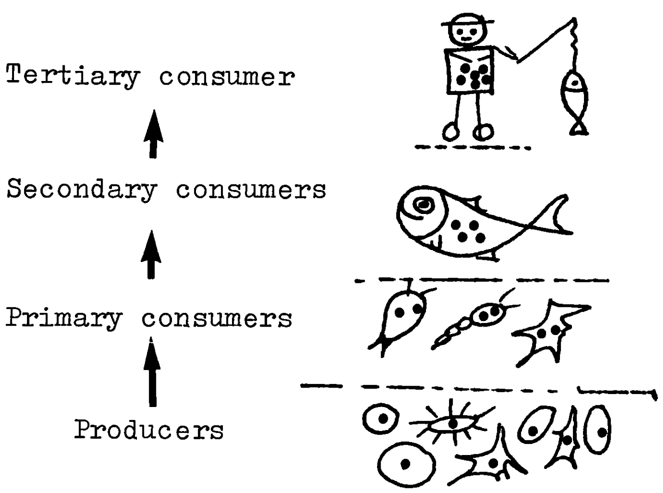
a) Law of conservation of energy

b) Pyramid of energy

c) Pyramid of mass

*d) Pyramid of numbers

e) Materials cycle



The sign ● represents the density of D.D.T. molecules in the bodies of the living organisms

15) In which of the terrestrial ecosystems may one come across much succulent and spiny vegetation?

a) Tundra

b) Tropical forest

c) Grassland

d) Taiga

*e) Desert

16) Which one of the following methods is the best to calculate the population density of fish that exist in a lake?

a) To count them one by one

b) To count and recount them all

c) To catch them all and count them

*d) To random sample them

e) To count their number and divide this value by the surface area of the lake.

17) Which one of the following living organisms are "consumers"?

a) Geranium plants

b) Sulphur bacteria

c) Phytoplanktons

d) Cherry trees

*e) Fish

18) Which one of the following molecules is the "structural units" of the proteins?

*a) Amino acids

b) Fatty acids and glycerol

c) Simple sugars

d) Enzymes

e) None of them

19) Javad is called a "primary consumer" when he eats a food material such as lettuce. What kind of consumer is he called when he eats an egg?

a) Primary consumer

*b) Secondary consumer

c) Tertiary consumer

d) Producer

e) None of the above

20) Organic materials are not directly consumable by the living organisms called "consumers". Which of the following sentences best explains this.

a) Consumers have no digestive organs.

b) Organic materials must be made from raw materials.

c) Organic molecules are water soluble and pass through cell membrane.

*d) Organic molecules are large and do not absorb by cells.

e) Organic molecules are easily absorbed by cells.

21) Name two different examples of "decomposers" in living organisms and write them on the answer sheet in the space provided.

22) Which one of the following living organisms are "decomposers"?

a) Sulphur bacteria

b) Green algae

*c) Bread moulds

d) Crabs

e) Rabbits

APPENDIX 6

VALIDATING THE BIOLOGY TEST ITEMS

Validating The Biology Test Items

Dear Colleague,

The Biology test, form A and form B, measures various types of behaviour and mental ability:

1. Knowledge: Knowledge refers to the ability to remember, select and recall a word, a sentence or a part of the textbook, to answer a question.
2. Comprehension: Comprehension refers to the ability to explain the meaning of memorized material. Or, ability to interpret different materials and explain them in one's own language.
3. Application: Application refers to the ability to use learned material in a new and concrete situation. It may include a higher understanding of the knowledge and applying it in a novel situation to find the required answer.

After studying the form A and B of the Biology test, please decide the right answer for each individual question. Write this right answer on the following table, opposite its corresponding question. Then, by writing an "X" opposite that question, indicate which of the above abilities is measured by this question when a student provides a right answer.

e.g. For the sample question 1 the right answer is "C" and the ability to be measured is "Knowledge" (see the table below).

	Form A				Form B			
Question No.	Answer	Knowledge	Comprehension	Application	Answer	Knowledge	Comprehension	Application
Sample qu.1	C	X			C	X		
Question 1								
Question 2								
Question 3								
Question 4								
Question 5								
Question 6								
Question 7								
Question 8								
Question 9								
Question 10								
Question 11								
Question 12								
Question 13								
Question 14								
Question 15								
Question 16								
Question 17								
Question 18								
Question 19								
Question 20								
Question 21								
Question 22								
Question 23								

APPENDIX 7

TEACHERS' QUESTIONNAIRE

October 1976

Dear Colleague,

The New System of Education introduced the Science of Ecology into the Secondary School Curriculum. It was assumed that the implementation of this curriculum would have few teaching difficulties. But, during the last three years, it was shown that the nature of the problem is more complicated than was expected.

The enclosed questionnaire is part of a research project on science education. The objective of this research is to study the process of the Biology Curriculum development in the first year of general secondary education of the new system of education in Iran.

The research results can be useful in understanding the three following aspects:

1 - By the study of the process of the Biology Curriculum, the difficulties of the teaching as well as the good and bad aspects of the curriculum can be specified.

2 - The obtained results will help in future curriculum planning and in the revision of the textbook.

3 - The tests based on the basic concepts of the textbook will help to diagnose students' difficulties in learning and show how to reduce them.

The questionnaire is anonymous and there is no need to write your name and other identification data.

Finally, I hope, you will cooperate with this research by providing your valuable information obtained as a result of teaching this curriculum. Please complete the questionnaire by ——— and return it with the stamped, addressed envelope that is enclosed.

Yours sincerely

JAVAD HASHEMI TAFRESHI

Faculty of Education - Tehran.

Teachers' Questionnaire

"A Study of the Process of the New Biology Curriculum Development in the First Year of the General Secondary Education"

Guide to the questions:

The questionnaire items are constructed to study various aspects of the process of the new Biology Curriculum development in the first year of the general secondary education. These aspects are categorized into four sections:

1 - General information.

2 - New system of education and the new Biology Curriculum.

3 - Teaching and learning the new Biology Curriculum.

4 - In-service training and the problems of the implementation of the Curriculum.

The questions are also of four different types:

1) questions which are answered by writing a number or a word on the dotted line, opposite each question, e.g.:

   a) one number: How many years have you been teaching? .. 12 ..

   b) a single word: What is your specialized subject? Zoology.

2) questions which are answered by writing an "X" in the box opposite the question, e.g.:

   Which of the following certificates do you have?

   Secondary school diploma $\boxed{X}$

3) questions which are answered by the use of a scale, e.g.

a) To what degree does the practical work done in the Study of Ecology stimulate the interest of the students?

very much	~~much~~	some	little	very little

b) In the following table some of the aims of the new sport curriculum are listed. Please rate the "desirability" and "practicality" of these aims by using numbers corresponding to each category in the following scale.

1 - very little   2 - little   3 - some

4 - much   5 - very much

Aims	Desirability	Practicality
1-Development of sport enthusiasm	4	2

The answer for question "a" indicates that the effect of experimentation has a great effect in stimulating students' interest in Ecology. The answer for question "b" indicates that although "to develop sport enthusiasm" in secondary school is *a very desirable* aim, in practice, and in the present school situation, little could be achieved.

4) questions that are answered by the use of a sentence or a paragraph, e.g.:

a) one sentence: What were your colleagues' attitudes towards the new curriculum?

b) one paragraph: What other comment do you want to make about the Biology Curriculum.

You may use the reverse side of the relevant page in case of a shortage of space.

Chapter One - General Information

1 - How long have you been teaching? ....

2 - How long have you taught in this town (city)? ....

3 - What is your original specialization? ....

4 - What subject(s) do you teach? ....

5 - Marital status: Single ☐ Married ☐

6 - Sex Male ☐ Female ☐

7 - In the present year, how many *hours* do you teach at any of the following *levels?*

(1) Guidance cycle ☐
(2) First year (new system) ☐
(3) 2nd & 3rd year (new system) ☐
(4) 4th & 5th year (old system) ☐
(5) 6th year (old system) ☐
(6) Normal school ☐
(7) Guidance T.T.C. ☐
(8) Evening classes ☐
(9) Higher Educ. Inst. ☐
(10) Others (please specify) ☐

8 - Which of the following *certificate* and qualifications do you have?

(1) Secondary School Diploma ☐
(2) Normal School Diploma ☐
(3) Guidance T.T.C. Diploma ☐
(4) Licence from N.T.T.C. ☐
(5) Licence from a Faculty of Educ. ☐
(6) Licence from a Faculty of Sci. ☐
(7) Master & other higher degrees ☐
(8) Others (please specify) ☐

9 - In the previous years, how many *years* have you taught in any of the following levels?

(1) First cycle (old system)	
(2) Guidance cycle	
(3) First year (new system)	
(4) 2nd & 3rd year (new system)	
(5) 4th & 5th year (old system)	
(6) 6th year (old system)	
(7) Normal school	
(8) Guidance T.T.C.	
(9) Evening classes	
(10) Higher Educ. Inst.	
(11) Others (please specify)	

10 - Please name any administrative responsibilities you have held in your career. ....

....

11 - If you had freedom to allocate all your weekly teaching hours to *one of the levels* mentioned in the question no.8 which one(s) would you choose? and why? ......

....

12 - What professions do you want to have in future? ....

....

<u>Chapter Two - New System of Education and the New Biology Curriculum at the First Year of the General Secondary Education</u>

13 - When you first knew about the new Biology Curriculum,

a) what attitude did you have? ....

....

b) what attitude can you recall from your colleagues?

....

14. When you first examined the new biology textbook,

    (a) what was your attitude about this textbook?

    ____

    (b) What attitude can you recall from your colleagues?

    ____

15 - In the following table the aims of the new Biology Curriculum are listed. Please rate the "desirability" and "practicality" of these aims by using numbers corresponding to each category in the following scale:

1 - very little   2 - little   3 - some   4 - much
5 - very much.

Aims	Desirability	Practicality
(1) Development of scientific attitudes.		
(2) Development of interest in solving daily problems by scientific approach.		
(3) Development of ability to apply his biological knowledge in using new equipment in daily life.		
(4) Development of skills in using laboratory equipment.		
(5) Following safety rules in carrying out experiments.		
(6) Familiarization of the pupils with scientific terms that they may encounter in daily life.		
(7) Understanding similarities and diversities amongst organisms in nature.		
(8) Understanding the status of man in the living world: that he is a living organism similar to others.		
(9) Acquisition of minimum knowledge by the pupils who will be exposed to different subjects of the theoretical studies.*		

*This aim was omitted in the process of typing the Farsi version.

16 - What other aims do you consider the Biology Curriculum should pursue? ....

....

17 - Which of the above aims (question 15) have been expressed successfully in the textbook?

Aim(s) Number ....

18 - What is your present attitude towards the new Biology Curriculum? ....

....

Chapter Three - Teaching and Learning the New Biology Curriculum

19 - When you first taught this Curriculum, which of the following were your difficulties? Please specify them by inserting an "X" in the space provided.

(1) Unfamiliarity with the knowledge of Ecology.	
(2) Did not know how to do the experiments.	
(3) Did not have any laboratory equipment.	
(4) Did not have any suitable space or a laboratory.	
(5) Could not answer the chapter questions.	
(6) Had no access to the relevant references.	
(7) Had problems due to a large number of students in the classroom.	
(8) Other difficulties (please specify)	

20 - Which of the above problems still persist?

Number(s) ....

21 - How many weeks do you spend teaching the Ecology section? ....

22 - How many hours per week do you spend on teaching?

....

23 - Which of the following methods do you think is the most effective one for teaching the new Biology Curriculum?

(1) One or more students read out some part of the book, then the teacher describes that topic afterwards.

(2) The teacher describes the topic first, then few pupils read it aloud afterwards.

(3) The teacher dictates a summary of the chapter to the class.

(4) The teacher dictates the basic concepts to the class in the form of questions and answers.

(5) The teacher dictates whatever he thinks is relevant to the class interests and abilities, and, usually puts aside the textbook.

(6) None of the above methods.

24 - What teaching method do you use? ....

....

25 - How do you handle the following in your teaching method?

a) The questions at the end of each chapter? ......

....

b) The experiments? ....

....

c) The references? ....

....

d) The activities outside the classroom? ....

....

26 - Which of the experiments can best be done in your school situation? ....

....

27 - Which of the textbook experiments do you believe is best to make the students understand a difficult ecological concept? ....
....

28 - Generally speaking, which of the following classify your students' difficulties in learning ecology?

(1) Reading the text. ☐

(2) Understanding the text. ☐

(3) Using the ecological terms in new context. ☐

(4) Relating topics of different chapters with each other. ☐

(5) Others .... ☐
(please specify)

29 - On the whole, how much are *your students* interested in Ecology?

very little	little	some	much	very much

30 - How much are *you* interested in teaching Ecology?

very little	little	some	much	very much

31 - Please write down three typical examples of examination questions you have used to test your students in the past.

(1) ....

(2) ....

(3) ....

Chapter Four - In-Service Training and the Management Problems

32 - How many in-service courses have you attended? ....

33 - How many were specially concerned with the new Biology Curriculum? ....

34 - To what extent is an in-service course helping you in the following areas?

(1) Ecological knowledge.	v.little	little	some	much	v.much
(2) How to do the experiments.	v.little	little	some	much	v.much
(3) How to teach this curriculum.	v.little	little	some	much	v.much
(4) How to answer the chapter questions.	v.little	little	some	much	v.much
(5) How to evaluate this curriculum.	v.little	little	some	much	v.much
(6) How to find relevant references.	v.little	little	some	much	v.much
(7) Others .... (please specify)	v.little	little	some	much	v.much

35 - When you first started to teach this curriculum, was your headmaster aware of your need for laboratory materials?

....

36 - Has he ever done anything to improve the situation? .....

37 - How many of the chapter references have you read? ......

38 - If you have been teaching the new Biology Curriculum but then abandoned it please describe your reasons ....

....

39 - Are you interested in co-operating with this research in future? Yes ☐ No ☐

40 - If yes, will you agree to be interviewed about some of the aspects you have answered above?

Yes ☐ No ☐

41 - If you are interested to receive the result of this research, please write your request on a separate paper and post it to the address on the enclosed stamped, addressed envelope.

Date............

Dear Colleague,

Hello, I hope that you have already received the questionnaire on the "Study of the Process of the New Biology Curriculum Development in the First Year of the General Secondary Education".

As was mentioned in the introduction of the questionnaire, the study does not end with the sending of the questionnaire. Your ideas and guidance, which are a result of your firsthand experiences from teaching at this level, can help a lot in the completion of the second stage; the development of Biology tests.

These tests will be developed on the basis of the principal concepts in the textbook and the Biology Curriculum. They provide a diagnostic device to detect student's difficulties in learning. The results obtained from these tests will specify each student's difficulties. Therefore, they will be a useful aid for the Biology teacher. A copy of these tests will be sent to you upon your request, when the test is executed in some school situations and it is validated by the use of statistical analysis.

Finally, I would like to emphasise that prompt response to the questionnaire will facilitate research and the return of the results to you.

Yours sincerely

JAVAD HASHEMI TAFRESHI

Faculty of Education - Tehran.

APPENDIX 8

STUDENTS' QUESTIONNAIRE

Students' Questionnaire

Dear Student,

This questionnaire is designed to investigate some aspects of the teaching and learning situations provided, at the first year of the secondary school, by the new Biology Curriculum.

Please read each question carefully and write its answer in the blank space provided. If the space is not large enough, you may continue on the back of the paper.

PLEASE NOTE THAT THE FOLLOWING QUESTIONS ARE ALL CONCERNED WITH THE FIRST SECTION OF YOUR BIOLOGY TEXTBOOK-ECOLOGY.

Question 1 - Have you studied any of the "References for further study" mentioned at the end of each chapter? If so, please write details (title, author's name, etc.) in the following space:

Question 2 - If your answer to the first question was positive, what factor made you study the references mentioned above? Specify your choice by inserting an "X" in the relevant space in this table:

Title of the book	Personal Interest	Teachers' suggestion

Question 3 - Which of the following experiments have you done? In the following, specify by inserting an "X" in the appropriate box, whether the experiment was carried out:

a) as a group activity in the classroom,

b) as the Teacher's demonstration in the classroom,

c) at home,

d) as a demonstration in the laboratory.

Experiment	Group activity	Teacher's demonstration	At home	Demonstration in the lab
1-"Bromo-Thymol" or "Bicarbonate indicator" experiment.				
2-"Ingenhousz's Experiment".				
3-Test of starch in a leaf.				
4-CO_2 absorbtion in leaves and its role in starch formation.				
5-Chromatography: Leaf pigments.				
6-Photography with leaves.				
7-The study of the Bread-mould.				
8-The study of the air pollution, with pine needles.				
9-Estimation of the density of the earthworm population in the school yard.				
10-Estimation of the accuracy of the sampling method.				

Question 4 - What other experiments or practical work have you done? If any, please give a detailed description of them.

Question 5 - Please write down the name of any Ecology films you have been shown?

Question 6 - How many times have you been taken to field work? What type of activities did you pursue?

Question 7 - If you have a class note-book, what sort of materials do you write in there? What is your usual source for the diagrams, drawings, etc?

Question 8 - How do you use the questions at the end of each chapter? Please answer by inserting an "X" in the appropriate box:

a) as a home-work, ☐

b) as the class exercise, ☐

c) as a project? ☐

d) never study them. ☐

Question 9 - What is your attitude about atomic explosions? Should they be banned? Why?

Question 10 - What is your attitude towards population control? Should the Iranian population be controlled? Why?

Question 11 - In which part of the textbook did you have difficulty? Please name the particular chapters.

Question 12 - What part of Section One - Ecology, did you find useful? In what way?

APPENDIX 9

CLASSROOM OBSERVATION SCHEDULE

Classroom Observation Schedule*

____
Date

____
Time

A. General Overview

1. Give a detailed description of the on-going classroom activities during the period of observation.
2. Sketch the room arrangement and activities during the period of observation.

B. More Specifically, to what extent did the teacher(s):

1. make the materials existing in the room available to pupils?

   not at all ____________________ completely
   1 2 3 4 5

   Notes:

2. have the room arranged into work areas?

   not at all ____________________ completely
   1 2 3 4 5

   Notes:

3. utilize the room according to these work areas?

   not at all ____________________ completely
   1 2 3 4 5

   Notes:

4. encourage or allow pupils to choose their own activities?

   not at all ____________________ completely
   1 2 3 4 5

   Notes:

---

*Gross, Neal, *et al.* (1971). *Implementing organizational innovations: A sociological analysis of planned educational change.* pp.236-238. New York, Harper Row.

5. allow pupils to decide whether they wanted to work individually, in pairs or in groups?

not at all ________________ completely
1 2 3 4 5

Notes:

6. allow pupils to move freely about the room?

not at all ________________ completely
1 2 3 4 5

Notes:

7. allow or encourage pupils to interact with each other?

not at all ________________ completely
1 2 3 4 5

Notes:

8. allow pupils to decide how long they wanted to remain at a particular activity - i.e., move freely from one activity to another?

not at all ________________ completely
1 2 3 4 5

Notes:

9. move about the room?

not at all ________________ completely
1 2 3 4 5

Notes:

10. try to work with as many individual pupils or groups as possible?

not at all ________________ completely
1 2 3 4 5

Notes:

11. try to act as a guide, catalyst, or resource person between pupils?

not at all ____________ completely
1 2 3 4 5

Notes:

12. try to act as a guide, catalyst, or resource person between pupils and the materials?

not at all ____________ completely
1 2 3 4 5

Notes:

APPENDIX 10

DATA OBTAINED FROM THE PILOT STUDY

10.0 Number of Objectives in the Details of the Goal Analysis of the Biology Textbook, 1975 Edition

Table 10.1: Number of objectives in the goal analysis.

Title	Number of General Objectives	Number of Specific Objectives
Introduction	7	16
Chapter 1	15	43
Chapter 2	5	15
Chapter 3	5	12
Chapter 4	12	33
Chapter 5	6	21
Chapter 6	8	23
Chapter 7	4	11
Chapter 8	8	25
Total	70	199

10.2 Raw Data Obtained from the Application of the Classroom Observation Schedule, on 9 Schools

Table 10.2: Raw data obtained from using the classroom observational schedule(1)

Schools	Type	Marks obtained for each item(2)
Darius (Tehran)	Comprehensive	1-1-1-1-1-1-1-1-1-1-1-1
Dayhim (Yazd)	Academic	1-1-1-1-1-1-1-1-1-1-1-1
Shahriar (Tehran)	Academic	1-1-1-1-1-1-1-1-1-1-1-1
M.R.Sh. (Tehran)	Comprehensive	1-2-1-1-1-1-1-1-1-1-1-1
Shahriar 1/3 (Tehran)	Academic	1-1-1-1-1-1-1-1-1-1-1-1
Babak (Tehran)	Academic	1-1-1-1-1-1-1-1-1-1-1-1
Irandokht (Yazd)	Academic	1-2-1-1-1-1-1-1-1-1-1-1
Iranshahr (Yazd)	Comprehensive	1-2-1-1-1-1-1-1-1-1-1-1
25 Shahrivar (Tehran)	Academic	1-1-1-1-1-1-1-1-1-1-1-1

(1) GROSS, N. *et al.* (1971). *Op. cit.* pp.236-238.
(2) See Appendix 9 for the actual items.

10.3 Details of the Students' Samples used in Achievement Test.

Table 10.3

Name of school	Number of students + the test: Form A	Form B	Total	Sex
Babak (Tehran)	31	27	58	Male
Darius (Tehran)	15	22	37	Male
Irandokht (Yazd)	23	22	45	Female
Iranshahre (Yazd)	25	29	54	Male
Mohammad R.Shah (Tehran)	25	26	51	Female
Shahriar $^1/_1$ (Tehran)	26	29	55	Male
Shahriar $^1/_3$ (Tehran)	25	26	51	Male
Total	170	181	351	F= 96 M=255

10.4 Raw Data from Teachers Rated Curriculum Goals

Table 10.4:(1)

Individuals	Goals: 1 - Desirability	2 - Practicality
1	3-5-5-4-4-5-5-3-4	2-3-5-4-3-4-4-3-3
2	2-5-5-5-3-3-5-4-5	2-2-5-5-2-2-3-4-3
3	2-4-5-5-5-5-3-5-5	2-3-3-3-3-4-4-3-3
4	3-5-5-5-3-3-4-5-5	4-1-3-2-3-3-3-2-4
5	2-4-2-3-2-2-4-4-4	2-2-2-2-3-2-2-2-2
6	2-5-4-4-3-3-4-4-4	2-4-5-3-4-3-3-3-3
7	- 5-5-4-4-4-4-4-5	- 3-5-2-3-4-4-4-3
8	4-5-5-5-5-5-5-5-5	4-2-5-3-4-4-4-5-3

(1) See Appendix 7 for the details of the goals.

10.5 <u>Tables of Specification of the Items used in the Forms A and B of the Pilot Study</u>.

<u>These Tables correspond with Appendix 5 and the Pilot Study</u>

Further details about correlation between items and codes used for computer programmes can be found in Appendix 13 - Achievement Test, Table 13.6a and Table 13.6b.

<u>Table 10.5</u>: Table of specification of the items used in Form A of the achievement test.

Topic	General Objective	Specific Objective	Content Congruent	Code number	
				Experimental	Pilot
Introduction	3.0 (p.262)	3.2 (p.263)	C.2 (p.294)	20A	1A
Introduction	2.0 (p.262)	2.1 (p.263)	C.2 (p.297)	-	2A
Chapter 1	1.4 (p.264)	1.42 (p.265)	C.6 (p.298)	15A	3A
Chapter 8	4.0 (p.280)	4.1 (p.281)	C.4 (p.322)	16A	4A
Introduction	3.0 (p.262)	3.2 (p.262)	C.2 (p.294)	6B	5A
Chapter 5	4.0 (p.275)	4.3 (p.276)	C.7 (p.313)	8B	6A
Chapter 5	2.0 (p.275)	2.2 (p.275)	C.2 (p.313)	17A	7A
Chapter 4	6.0 (p.271)	6.2 (p.273)	C.4 (p.309)	7B	8A
Chapter 1	1.2/1.3	1.25/1.34	C.3/C.4	12A	9A-a
Chapter 1	(pp.263/264)	(pp.265)	(pp.297/298)	13A	9A-b
Chapter 4	12.0 (p.272)	12.1 (p.274)	C.8 (p.310)	9B	10A
Chapter 6	7.0 (p.277)	7.1 (p.278)	C.3 (p.316)	-	11A
Chapter 6	8.0 (p.277)	8.4 (p.278)	C.4 (p.316)	11A	12A
Chapter 2	2.0 (p.268)	2.3 (p.269)	C.5 (p.304)	5A = 27B	13A
Chapter 1	1.6 (p.264)	1.61 (p.265)	C.8 (p.298)	-	14A
Chapter 2	1.0 (p.268)	1.2 (p.268)	C.2 (p.303)	18B	15A-a
Chapter 2	1.0 (p.268)	1.2 (p.268)	C.2 (p.303)	10A	15A-b
Chapter 2	1.0 (p.268)	1.2 (p.268)	C.2 (p.303)	19A	15A-c
Chapter 5	4.0 (p.275)	4.4 (p.276)	C.7 (p.313)	14A	16A
Chapter 6	2.0 (p.277)	2.1 (p.277)	C.2 (p.316)	18A	17A

Table 10.6: Table of specification of the items used in Form B of the achievement test.

Topic	General Objective	Specific Objective	Content Congruent	Code number	
				Experimental	Pilot
Introduction	6.0/8.0	6.1/8.1	C.8/C.4	-	1B
Chapter 6	(pp.262/277)	(pp.263/278)	(pp.295/314)	-	1B
Introduction	2.0 (p.262)	2.1 (p.266)	C.12 (p.298)	7A	2B
Chapter 1	1.7 (p.264)	1.73 (p.266)	C.9 (p.298)	6A	3B
Chapter 5	3.0 (p.275)	3.3 (p.275)	C.3 (p.313)	16B	4B
Chapter 8	7.0 (p.280)	7.4 (p.282)	C.7 (p.322)	15B	5B
Chapter 4	1.0 (p.271)	1.3 (p.272)	C.1 (p.309)	-	6B
Chapter 2	1.0 (p.268)	1.2 (p.268)	C.2 (p.303)	-	7B
Chapter 4	8.0 (p.271)	8.3 (p.273)	C.4 (p.309)	8A	8B
Chapter 6	5.0 (p.277)	5.2 (p.278)	C.3 (p.316)	13B	9B
Chapter 4	3.0 (p.271)	3.2 (p.272)	C.3 (p.309)	19B	10B
Chapter 8	5.0 (p.280)	5.4 (p.281)	C.5 (p.322)	9A	11B
Chapter 2	1.0 (p.268)	1.1 (p.268)	C.1 (p.303)	20B	12B
Chapter 1	1.10 (p.264)	1.101 (p.266)	C.11 (p.298)	22A	13B
Chapter 1	1.2/1.3	1.24-25/	C.3/C.4	11B	14B-a
Chapter 1	(p.263)	1.33-34 (p.265)	(pp.297-298)	12B	14B-b
Chapter 4	5.0 (p.271)	5.2 (p.273)	C.3 (p.309)	14B	15B
Introduction	1.0 (p.262)	1.1 (p.263)	C.1 (p.294)	21A	16B
Introduction	4.0 (p.262)	4.1 (p.263)	C.8 (p.295)	23A	17B
Chapter 1	1.1 (p.263)	1.11 (p.264)	C.2 (p.297)	1A = 23B	1
Chapter 1	1.1 (p.263)	1.13 (p.264)	C.2 (p.297)	2A = 24B	2
Chapter 1	1.1 (p.263)	1.13 (p.264)	C.2 (p.297)	3A = 25B	3
Chapter 1	1.1 (p.263)	1.12 (p.264)	C.2 (p.297)	4A = 26B	4

Table 10.7: Distribution of the psychomotor objectives in the eight chapters of the textbook.

Psychomotor Objectives (1)	Chapters							
	1	2	3	4	5	6	7	8
1. To set up laboratory experiments correctly.	/	/	/		/			
1.1 To identfy apparatus.	/	/	/		/			
1.2 To assemble them correctly.	/	/	/		/			
2. To perform laboratory techniques with safety and care.	/	/	/		/			
3. To draw accurate and simple diagrams.		/						
4. To present the results in an exhibition.			/					

(1) Extracted from Appendix 2.

Table 10.8: Distribution of affective domain in the eight chapters of the textbook.

Affective Objectives (1)	Chapters							
	1	2	3	4	5	6	7	8
1. To answer questions	/	/	/	/	/	/	/	/
2. To read references	/	/	/	/	/	/	/	/
3. To report back his performed experiments	/	/	/		/			
4. To modify experiments	/							
5. To identify the danger of an atomic explosion				/				
6. To appreciate the role of science in explaining phenomena				/				
7. To propose a plan for population control					/			
8. To report his observations to the class						/	/	/
*9. To display safety consciousness	/	/			/			
*10. To practise co-operation in group activities	/	/			/			

(1) Extracted from Appendix 2.

* Should be evaluated in practical sessions.

APPENDIX 11-a

THE DETAILS OF THE CURRICULA IN THE OLD AND NEW SYSTEM OF EDUCATION

1. Primary School Curriculum. Table 11.1 is the six-year curriculum of the old system of education. Table 11.2 is the curriculum of the 5 years of primary education in the new system of education.

Table 11.1*

Subjects / Grades	1st	2nd	3rd	4th	5th	6th
1. Persian	12	12	9	9	7	7
2. Arithmetic & Geometry	2	2	4	4	4	4
3. Religious Instruction	3	3	2	2	3	3
4. Physical Exercises	2	2	2	2	2	2
5. History & Geography	-	-	2	2	4	4
6. Painting & Handicraft	5	5	5	5	6	6
7. Singing	-	-	-	-	1	1
8. Calligraphy	-	-	-	-	1	1
9. Natural Science & Hygiene Sanitation	2	2	3	3	1	1
Total hours per week	26	27	27	27	29	29

*Ministry of Education (1966). *General principles of elementary education*. p.3.

Table 11.2*

Subjects / Grades	1st	2nd	3rd	4th	5th
1. Persian	12	12	9	9	8
2. Arithmetic & Geometry	3	3	4	4	5
3. Religious Instruction	2	2	3	3	3
4. Physical Educ. & Games	2	2	2	2	2
5. Social Sciences	2	2	3	3	3
6. Art & Handicraft	5	5	4	4	4
7. Science & Hygiene	2	2	3	3	3
Total hours per week	28	28	28	28	28

*Ministry of Education (1966). *Detailed programme of study for the five-year primary education.* p.17.

2. First Cycle and Guidance Cycle Curriculum. Table 11.3 is the curriculum of the three years of the first cycle in the old system of education. Table 11.4 is the curriculum of the three years of the guidance cycle in the new system of education. The number of hours per week devoted to each subject is indicated.

Table 11.3:First Cycle[1]

Subjects / Grades	Hours per week		
	1st	2nd	3rd
1. Persian	6	6	5
2. Mathematics	4	4	4
3. Religious Instruction	2	2	2
4. Physical Education	2	2	2
5. History & Geography & Civics	3	3	3
6. Home Economics (girls Handicrafts (boys)	3	3	2
7. Natural Science & Hygiene	2	2	2
8. Foreign Language	4	4	4
9. Calligraphy	1	1	1
10. Drawing	1	1	1
11. Physics & Chemistry	2	2	4
12. Arabic	2	2	2
Total hours per week	32	32	32

[1] UNESCO. (1961). UNESCO survey of education. p.667.

Table 11.4: Guidance Cycle[1]

Subjects / Grades	Hours per week 1st	2nd	3rd
1. Persian	6	5	5
2. Mathematics	5	5	5
3. Religious Instruction	3	3	3
4. Physical Education	2	2	2
5. History & Geography & Social Studies	3	3	3
6. Art (Painting, Calligraphy, Sculpture & Music)	2	2	2
7. Combined Sciences (Physics, Chemistry, Biology & Hygiene)	5	5	5
8. Foreign Language	4	4	4
9. Principle of Technical and Vocational Education	4	4	4
10. Arabic	-	1	1
Total hours per week	34	34	34

(1)Ministry of Education (1967). *Detailed programme of study for the three-year guidance period.* p.IV.

3. Second Cycle and Secondary Education Curriculum - Branch Natural Science. Table 11.5 is the curriculum of the three years of the second cycle in the old system of education, branch natural science. Table 11.6 is the curriculum of the three years of the general secondary education in the new system of education, branch natural science. The number of hours per week devoted to each subject is indicated.

Table 11.5: Second Cycle[1]

Subjects / Grades	Hours per week 1st	2nd	3rd
1. Persian Language & Literature	5	5	5
2. Mathematics	3	3	2
3. Physics	4	4	4
4. Chemistry	4	4	4
5. Natural Science & Hygiene	5	5	9
6. Foreign Language	4	4	4
7. Logic & Philosophy	-	-	2
8. Religious & Moral Instruction	1	1	-
9. Drawing & Manual Training (boys) Home Economics (girls)	2	2	-
10. Physical Education	2	2	2
11. Social Studies (History & Geography)	2	2	-
Total hours per week	32	32	32

[1] TOUSSI, M.A. (1966). *Present educational system in Iran.* p.10.

Table 11.6: General Secondary Education[1]

Subjects / Grades	Hours per week		
	1st	2nd	3rd
1. Persian Language & Culture	6	6	6
2. Calculus & Algebra	4	2	2
3. Modern Maths.	2	-	-
4. Trigonometry	-	2	1
5. Geometry	3	2	1
6. Biology	2	4	4
7. Foreign Language	4	4	4
8. History of Iranian Civilization	-	-	2
9. Geography & Environmental Studies	-	2	-
10. Social Sciences	2	-	-
11. Physics	3	3	3
12. Chemistry	2	3	3
13. Geology	-	-	2
14. Physical Education	2	2	2
15. Religious & Moral Instruction	2	2	2
16. Technical Education	2	2	2
17. Laboratory Works	2	2	2
Total hours per week	36	36	36

[1] VADI'I, K. (1974). *Op. cit.* in *Educational Monthly*. p.17.

APPENDIX 11-b

A CHRONOLOGICAL HISTORY OF SOME OF THE IMPORTANT EDUCATIONAL EVENTS IN THE IRANIAN MODERN SYSTEM OF EDUCATION

1906 A Constitutional Monarchy was established. Article XVI of the fundamental law of 30th December ordered the establishment of the Ministries, subject to the approval of the parliament. (1).

1910 Parliament passed a law concerning the administrative organization of the Ministry of Education. Article 1 Section one was concerned with the following departments: (a) Public Education; (b) Higher Education; (c) Endowment; (d) Research; (e) Inspection; (f) Accounting; and (g) The Higher Council of Education. Article 1 Section two was concerned with duties, responsibility and power of the Minister of Education, the General Director of Education, and the Heads of the above-mentioned departments. It specified the function of the departments. (2).

1911 The Fundamental Law of Education, Act of 1911, was approved by the parliament. (3). According to this law primary education was compulsory and free for all.

1928 A bill for the provision of scholarships for the education of Iranian students abroad was passed by the parliament.

1932 The Higher Council of Education approved regulation and syllabus for Kindergarten.

1934 The Teachers Training Act authorized the construction, improvement and the expansion of primary and secondary teacher-training institutions. (4).

1934 The Higher Council of Education passed a regulation concerning the curriculum of primary and secondary schools.

1934 The Department of National Examination was established to set up national examinations and to grant diplomas and certificates.

1935 Co-education was introduced into primary schools.

1943 A law was passed which contained specific regulations concerning textbooks: their distribution among poor children was to be free of charge; primary education was divided into urban (6 years) and rural (4 years) areas. (5).

1950 Landlords were obliged by the Village Improvement Law to allocate 20 percent of their crop share to village development and educational activities. (6).

1954 Teachers' salaries were increased.

1960 A Centre for Educational Documentation and Study was established to collect information about Iranian and foreign educational systems. (7).

1962 The establishment of the Department of Audio-Visual Aids. (8).

1963 The establishment of the Department of Curriculum Planning and Research. Formation of Literacy Corps. (9).

1964 The Department of School Libraries was established to set up and organize school libraries. (10).

1964 National Teachers Training College was reorganized to include an educational research unit, and a department for training headmasters in its organization. (10).

1965 A National Commission on Education was formed to assess educational aims and practice in Iran. It proposed certain changes in the system in the light of socio-economic requirements of the country. (11).

1965 The Ministry of Culture and Art was established to protect and promote Iran's cultural heritage. (12).

1966 The National Council of Education published its plan for the reorganization of the primary and secondary education.

1968 A Ministry of Science and Higher Education was established. (13).

1968 The establishment of administrative and educational revolution. (14).

1975 The establishment of free education for all.

1975 Revision of secondary education. (15).

1976 Further revision of the new system of education at the Ninth Ramsar Seminar.

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APPENDIX 12

THE BIOLOGY CURRICULUM ANALYSIS SCHEME (BCAS)

The Biology Curriculum Analysis Scheme was developed to fulfil the following general objectives:

1. To provide a general information about the biology curriculum materials, and also specific data about students' textbooks, to an English reader of the present thesis.
2. To provide a comprehensive analysis of the contents of the textbook to facilitate intrinsic evaluation, goal analysis and the development of measurement instruments for extrinsic evaluation.

The BCAS consists of two sections:

Section One : Description of the curriculum materials:

1.1 Introduction to the materials

1.2 Authors' rationale

1.3 Characteristics of the target population

1.4 Typical students' daily time-table

1.5 Examination system

1.6 Pupils' ability

1.7 The school situation

Section Two : The analysis of the contents of the biology textbook:

2.1 General description of the contents of the biology textbook

2.2 Analysis of the contents of the textbook chapters

2.2.1 Technical terms

2.2.2 Details and sequence of concepts and principles

2.2.3 Patterns of presentation of concepts and principles

2.2.4 Illustrations

In Appendix 3, the analysis of the biology curriculum content was carried out by the application of the above scheme. In this analysis, the changes in the biology textbook in its later editions were omitted to maintain continuity of the analysis. However, details of these editions were carried out and are to be found in Appendix 4.

APPENDIX 13

THE ACHIEVEMENT TEST - TECHNICAL REPORT

In 1974, a new biology curriculum was introduced into the Iranian system of education for the two years study at the general secondary level. In the following year this level was reduced to one year's study, and of all the topics that were included in the biology curriculum, that of ecology remained intact. This topic has been since taught at the first year of the secondary education.

The biology achievement test was developed on the basis of the 1975 edition of the biology textbook. The main objective of this test was to measure students' cognitive attainment in terms of the ecology curriculum objectives. The assessment of affective and psychomotor objectives was carried out by the use of interviews, checklists and questionnaires, all of which have been described elsewhere.

13.1 Domain Development and Item Generation

The biology curriculum had the following characteristics:

1. There was no detailed list of specific objectives. The curriculum general goals were guidelines for the development of the textbook and instructional methods (Appendix 1).
2. The two specific objectives for the ecology syllabus were concenred with either:
   (a) understanding similarities and differences amongst organisms in nature, or;
   (b) understanding the status of man in the living world, i.e. that he is a living organism with

similar functions to, and having a close relationship with other organisms on the earth.

These objectives could not be used for assessing all the possible effects of the curriculum in question.

Therefore, it was necessary to develop a strategy for specification of objectives, and a description of the details of the textbook, prior to the development of the test. This procedure was also needed for the development of criterion-referenced test validity procedure since it should be based on clearly defined curriculum tasks and objectives.

The reasons for choosing a criterion-referenced test, rather than a norm-referenced test, for evaluating the effectiveness of the biology curriculum have already been discussed in various parts of this thesis. It is sufficient to mention that the present study was not concerned with a comparison between individual's scores and those of their norm groups. On the other hand criterion-referenced tests have the following features: (1)

1. They are based on clearly defined educational tasks and purposes.
2. Tests are specifically designed to measure the purpose of the tests.
3. Scores are interpreted in terms of attainment, a pre-set criterion, or level of competence with respect to the purposes and tasks.

which provide more meaningful data for the interpretation of the effectiveness of the biology curriculum development. Also, these qualities were more relevant to the following objectives of the present study:

1. To measure students' cognitive attainment as the result of the curriculum and instruction effects.
2. To assess students' achievement, independently from their norm group, in terms of specific objectives.
3. To develop a functional model for achievement testing which could be used for classroom examination.

A criterion-referenced test can provide data for the above enquiries. It maximizes differences between groups and minimizes differences between individuals, a quality which makes it a desirable instrument for a large-scale curriculum evaluation study. (2).

13.1.1 Domain Development

One of the basic features of criterion-referenced tests (CRT) is their dependence on clearly defined curriculum tasks and purposes, which together constitute the CRT's domain. Domain in this context has been used as equivalent to a specific objective. (3).

Various authors have assumed different interpretations of the domain definition which have led to the development of various approaches for item generations. (4). The main issue in these approaches was to start item generation from a clearly defined task or purpose which could provide a manageable universe of items.

The lack of a list of specific objectives for the biology curriculum required a detailed specification of the curriculum goals and those of the textbook. The problem with the textbook was that, until a full analysis of its concepts and principle could be carried out, any specification of the outcomes could lead to the development of ambiguous objectives.

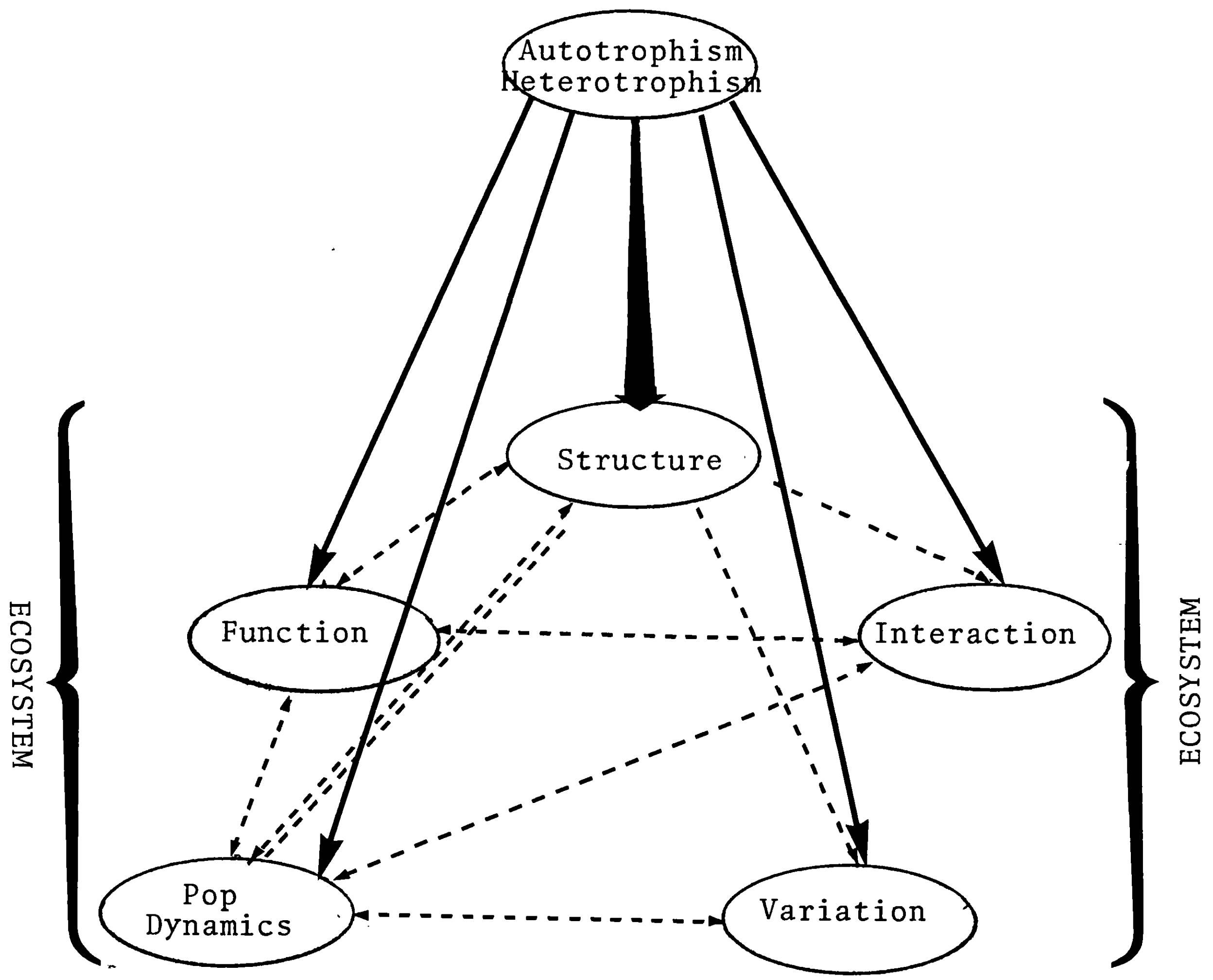
Curriculum analysis provided a detailed analysis of the contents of the textbook. In this, details of each topic and descriptions of all the activities in each chapter were analysed. All the technical terms were listed and the sequence and development of the concepts and principles described (Appendix 3).

In the above analysis the terminal unit of content analysis of the textbook was considered to be a technical term. Technical term was used as equivalent to domain in the analysis and was defined as "a word or phrase which, when used within the content of ecology, carries a single scientific meaning". (5). This scientific meaning could have been a concept or a principle in the content of the textbook.

As the subject of ecology, for first year students in secondary education, was at an elementary level, details of many of the technical terms were very limited. In most cases they were limited to one sentence, the definition of the technical terms. This characteristic restricted the extent of the content analysis and prevented the creation of numerous items. (6).

The above analysis of the content of the 1975 edition of the biology textbook showed that there was an inbuilt sequence in the development of the concepts and principles which had been altered in the later editions (see Figure 13.1 below). The existence of this sequence suggested that the learning of certain concepts was critical for the attainment of other concepts introduced in later chapters. The following complex example illustrates some of the points made above:

Figure 13.1: Developmental sequence of concepts and principles in the biology textbook, 1975 edition.



In the first part of the textbook (1975 edition), concepts of producers, consumers and decomposers were introduced. These concepts were defined in terms of students' background knowledge, to provide a simple meaning for each technical term. For example, the concept of producer was defined as living organisms (green plants) that could produce their required organic materials (foods) from inorganic matter. In this definition emphasis was placed on (a) organic material, (b) food as organic material, (c) inorganic matter, and, (d) green plants as producers.

The mechanism of how inorganic materials could be changed into organic materials (Photosynthesis and Chemosynthesis) and the question of varieties of producers (Autotrophs and Heterotrophs) were dealt with in chapters one and two.

In the above case, it had been assumed that students had already known something about the technical terms that were used for the definition of the producer. However, a study of the later part of the textbook shows this assumption was not totally true. The background concepts were explained in some detail in later parts in order to revise them before introducing new terms.

In this case, in the specification of the content domain, not only was the concept of producer included, but also the background concepts were listed as sub domains. Therefore, at the end of the analysis the following technical phrases were identified:

1. Green plants as producers.
2. Food as organic materials.
3. Inorganic materials, i.e. fat, sugar, protein.
4. Inorganic matter, water, carbon dioxide, minerals.
5. Green plants as producer of food.
6. Green plants as producer of organic materials from inorganic materials.

At the end of the content analysis a tally was made on the repeated phrases and then they were allocated to their appropriate chapter where they first appeared (see Appendix 3).

When the results from the curriculum analysis were ready, it was not difficult to translate them into behavioural objectives. Both curriculum goals and the details of the contents of the textbook were translated, in the process of goal analysis, into general and specific objectives. Again, the specifications of the objectives were limited by the details of the content analysis. In this process 70 general objectives and 199 specific objectives were identified. These objectives were scrutinized for their content-objective congruences until these criteria were satisfied (Figure 6.1, Chapter 6).

Details of the goal analysis showed that the list of the cognitive objectives in the textbook were not as comprehensive as those in the curriculum goal analysis (Appendix 2, Table 2.1). It was decided to use these objectives for the development of the criterion-referenced test, since the objective of the present evaluation was to evaluate what students learnt not what they ought to learn. This decision was also based on the assumption that in

Iranian schools the only source for teaching and learning was the textbook, which is printed and distributed by the Ministry of Education. In most of the schools, what students learnt was limited by how teachers used the textbook.

13.1.2 Item Generation

Specific objectives developed from the results of the goal analysis and the curriculum analysis were used as domains for item generation.

As a general rule, one or more (up to three) test items were developed to measure the attainment of each domain (specific objective). This decision was reached from the study of the details of the specific objective. In most of the cases, details of these objectives were limited. When a simple definition of a phrase was required and no other technical terms were involved, a single test was considered to be sufficient for the measurement of the objective. Otherwise three or more items were developed to measure the most appropriate outcomes of the objective.

The test items for the pilot study were open-ended and short-answered questions. These items were similar to those tests that students had experienced in their classroom examinations. These tests were used to obtain a variety of distractors needed for the development of the multiple choice questions. (7). These multiple choice questions were designed for use in the evaluation of the effectiveness of the biology curriculum. The pilot study also provided data for revision of the test stems.

A stratified random sampling procedure was applied to select items. In this process each specific objective was treated as a stratum for item selection. The decision as to the number of test items was influenced by the management of the test.

In Iranian schools, most of the classrooms are small and crowded. In this situation, when an examination hall is not available, the degree of cheating invalidates the test results. To solve this problem, and also that of the time limit for each session, it was decided to have two test forms. This decision provided a chance to double the number of items that could be selected from the item pool. The number of questions that students could answer in 50 minutes had to be limited to avoid the condition of "time tests". It was decided to include up to 23 test items in each test form. By this procedure 42 test items were selected and distributed into two test forms. Test form A with 21 items and test form B with 21 test items.

The test items were scrutinized for their item-content-objective congruencies. As the result, several test items, e.g. Q.9, Form A, had to be divided into parallel test item forms in order to reduce the ambiguity of the test. At the end of this process the total number of test items reached 45 (see Appendix 5 for the details of test items).

Finally, a Ph.D. panel examined the English version of the test and made several suggestions for item improvement. These improvements were also reflected in the Farsi version (Appendix 17 microficshe).

Tables 10.5 and 10.6 in Appendix 10 represent the details of the pilot study item-content-objective congruencies of the test items.

13.1.3 The analysis of pilot study test versions and the development of the experimental or field work version of the achievement test

It has been argued that a score obtained from a good CRT item should not discriminate amongst individuals. This assumption was true when the test item had been tried by a small group of individuals who were exposed to the same instruction. (8). It followed that a good criterion-referenced test score was non-discriminating. A positively discriminating item was that which indicated deficiency in the instruction. A negatively discriminating item related to items that were either too difficult or too easy.

The above arguments were only true when a group of homogeneous items could be developed to measure one specific objective (or domain), and when the test was tried on a homogeneous group of students (one class), i.e. those having the same instruction. In this condition variance of the items scores would not be large.

In the case of the biology test, not only were the items heterogeneous in terms of objectives and their levels of learning. They had also been tried on heterogeneous groups of students. Therefore variance in the scores was inevitable. (9).

In the process of the test development no assumption was made about test difficulty. It was argued, since the test items were based on textbook objectives which students were required to master, that they should all have achieved equally had the instruction been sufficient.

The calculation of item facility for the criterion-referenced test provided information both about ambiguity of the item and the instruction. Item facility was defined as the percentage of students who get an item correct, and the error rate was defined as the proportion of students who scored an item incorrectly. Therefore the error rate was one minus the item facility value.

If an item has a high error rate, it is either because it is ambiguous or the instruction was not sufficient. The same argument could be true for item discrimination discussed above. A positively (and some negatively) discriminating item may suffer from those deficiencies mentioned for item difficulties.

Where variance in the item score was inevitable, it could be reduced to a minimum, to produce a valid result. The source of variance error, as argued above, was either due to instruction or ambiguity of the item. Since variability of instruction could not be controlled, most of the effort was concentrated on the refinement of the test items to reduce the effect of this variance on the interpretation of the results.

The pilot study tests were tried in six Academic schools (see Chapter 6). The results obtained from these schools were exposed to item analysis and reliability as used in norm-referenced measurement. These results, together with results obtained from item difficulty, and those obtained from procedures for validating the test, were used to analyse and revise the test and to develop multiple choice versions for the experimental groups.

The following procedures were used in the pilot study to validate the test items:

1. The two authors of the textbook examined the test items to detect any flaws in the content, grammar or language of the test.
2. A group of teachers were asked to examine the test items and report, (a) the test items that they would think were not measuring information included in the textbook, (b) whether the test items were ambiguous, and, (c) any reason why their students could not achieve any particular test item. In a few (four) classes the teachers were asked to go through the test items, after the testing session, with their students. This exercise provided some useful results. Teachers had claimed that they had taught all parts of the content of the biology textbook. However, from the conversation between the teacher and students, it was understood that their claims were not true. They had taught a selective part of the textbook and had reached certain agreement with their students. This result suggested that in many schools we might be dealing with a hidden curriculum. (10).
3. In each class, five students were randomly selected and interviewed about each test item. In this exercise, students were asked to read the test item aloud and try to answer it. In this way many

of the difficulties in wording, language and grammar of the questions were detected. If the test could be answered only after a short description by the author, the item was ambiguous.

4. In two classes, one in Yazd and the other in Tehran, students were asked to go through the textbook to find the answer to each question, write down the page number, and the section of that page relevant to the answer of the test. This exercise was useful to confirm the item-content congruency.

After the termination of the pilot study, the results obtained from the six schools were exposed to norm-referenced measurement item analysis. In this process reliability of Form A was calculated as 0.67 and for Form B 0.63. There was only one negatively discriminating item. Most of the items had a low discriminant index. Table 13.2 and Table 13.3 shows the results of the item analysis for the two test forms.

The low reliability and discrimination indices indicated that the test has an average low variance.

To reduce the ambiguity of those highly discriminating items, and the test as a whole, all the information obtained in the validating procedure was used to detect the origin of the ambiguity and to correct the test item. This procedure led to the following decisions about the test items.

1. Some items proved to be ambiguous because the objective was not specific enough to lead to a valid interpretation of the score. It was

Table 13.2: Pilot study - Reliability analysis for scale (Test A)

N of cases = 145.0

Item-Total Statistics	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q1	8.06207	12.05862	.19404	.29733	.66983
Q2	7.80000	12.21667	.11358	.19304	.67893
Q3	8.17241	12.42146	.11551	.20515	.67563
Q4	7.64138	12.59272	.01790	.07325	.68682
Q5	7.76552	11.54186	.31895	.28819	.65703
Q6	7.77241	12.02423	.17177	.26431	.67278
Q7	7.96552	11.70019	.27981	.25068	.66132
Q8	8.17931	12.09262	.24991	.19036	.66511
Q9	7.97241	11.62423	.30542	.22160	.65863
Q10	7.71724	11.89866	.21636	.20025	.66791
Q11	7.97241	12.04090	.17585	.21267	.67209
Q12	7.95862	12.70661	-.02290	.13526	.69206
Q13	8.09655	11.69895	.33391	.67631	.65671
Q14	8.05517	11.62193	.33690	.69500	.65591
Q15	7.9.724	10.84033	.54519	.41854	.63165
Q16	7.68966	11.67385	.29341	.28748	.65993
Q17	8.20207	12.62529	.08913	.23109	.67595
Q18	8.28276	12.53755	.16896	.13688	.67184
Q19	8.13793	11.81418	.32215	.47972	.65846
Q20	8.11724	11.50699	.41937	.57598	.64917
Q21	8.04828	11.53238	.36378	.58955	.65314
Q22	8.11724	12.21533	.16352	.14313	.67228
Q23	7.73103	11.71188	.27188	.26050	.66214

Reliability coefficients 23 items

Alpha = .67571 Standardized item alpha = .67440

Table 13.3: Pilot study - Reliability analysis for scale (Test B)

N of cases = 145.0

Item-Total Statistics	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q24	9.55172	11.05460	.16331	.28485	.63113
Q25	9.28966	10.63774	.24675	.30454	.62172
Q26	9.63448	11.26130	.12670	.22885	.63405
Q27	9.12414	11.13726	.10558	.27126	.63844
Q28	9.11034	11.00163	.15239	.13801	.63291
Q29	9.16552	10.54186	.29038	.24914	.61636
Q30	8.96552	10.86686	.26872	.24473	.62074
Q31	9.42759	11.16312	.09400	.12554	.63998
Q32	9.44138	11.05383	.13108	.13769	.63554
Q33	8.98621	10.80536	.27685	.22668	.61956
Q34	9.55862	10.92883	.21252	.22357	.62595
Q35	9.41379	10.50814	.30318	.27290	.61480
Q36	9.65517	11.19971	.16884	.16935	.63036
Q37	9.40690	11.22912	.07074	.25056	.64290
Q38	9.42759	10.84368	.19616	.15682	.62791
Q39	9.24828	10.13238	.41268	.29581	.60021
Q40	9.43448	10.92797	.17029	.18130	.63097
Q41	9.18621	10.66648	.24568	.45991	.62188
Q42	9.15172	10.25460	.39060	.55048	.60385
Q43	9.53103	10.51466	.34930	.31337	.61068
Q44	9.54483	11.02749	.17012	.20845	.63045
Q45	9.25517	10.77471	.20427	.15904	.62707

Reliability coefficients 22 items

Alpha = .63646 Standardized item alpha = .63600

decided further to specify these objectives and consequently divide them into more items, i.e. item 2 defined the word producer, which was divided into components as described in the example in 3.1.1 of this report. Then an item was selected from the universe to measure the most appropriate outcome of the sub-domain. (Item 7, Form A field work version.)

2. Some items proved to be ambiguous because of the ambiguity in wording, grammar, language or diagram. These items were modified.

3. Some items had led to interpretation of other objectives which were not intended to be measured by those items. (Question 16, Form A pilot study was such an item.) These items were corrected and checked for their item-content-objective congruencies until their validity of the test was satisfied.

4. Some items proved to be background knowledge that all students knew. In this case, if the item was not measuring an important concept and principle, which was essential for understanding a key concept in the textbook, it was omitted, as were those which could not be converted into multiple choice questions. (One such example was Question 14A about the structure of a dicotyledon leaf.)

5. Some items proved to be irrelevant in the 1976 edition of the textbook, i.e. the terms Heterotroph and Autotroph. They were omitted and

replaced by new items from the same domain.

6. Some items created a condition which is known as test wiseness. Students compare their responses to one item with those on similar items to correct their responses, i.e. question 15, Form A, pilot study version; was asking students to write down the name of the molecules which resulted from the digestion of protein, carbohydrate and fat molecules. This question was divided into three separate questions and they were dispersed in the two test forms to avoid test wiseness. The same procedure was followed for other items which showed the same characteristics. As the result of this procedure the item orders in the two test forms of the pilot study and field work versions were not identical. (See Table 13.5)

On the whole most of the items on the pilot study except 3 items were maintained (Table 13.5) in the field work versions. The corrected items were used as stems of the multiple choice question.

The answers given for each short-answered questions were used as the source for developing plausible distractors for the multiple choice questions. (11). In the whole process of item writing and revision of the test various guidelines in the literature were consulted. (12)(13)(14).

The final version of the test can be found in Appendix 5. The correlation between the pilot study test items and the field work test items and their codes in the computer programme are indicated in Table 13.4 and Table 13.5.

Table 13.4: Correlation of the item numbers on forms of the experimental and pilot study versions with the computer code numbers.

Form A				Form B			
Experimental		Pilot		Experimental		Pilot	
Text	Computer	Text	Computer	Text	Computer	Text	Computer
1	Q1	1	Q1	1	Q23	1	Q24
2	Q2	2	Q2	2	Q24	2	Q25
3	Q3	3	Q3	3	Q25	3	Q26
4	Q4	4	Q4	4	Q26	4	Q27
5	Q5	13A	Q18	5	Q27	13A	Q18
6	Q6	3B	Q30	6	Q28	5A	Q9
7	Q7	2B	Q29	7	Q29	8A	Q12
8	Q8	8B	Q35	8	Q30	6A	Q10
9	Q9	11B	Q38	9	Q31	10A	Q15
10	Q10	15A-b	Q20	10	(1) -	2B	Q29
11	Q11	12A	Q17	11	Q32	14B-a	Q41
12	Q12	9A-a	Q13	12	Q33	14B-b	Q42
13	Q13	9~~B~~A-b	Q14	13	Q34	9B	Q36
14	Q14	16A	-	14	Q35	15B	Q43
15	Q15	3A	Q7	15	Q36	5B	Q32
16	Q16	4A	Q8	16	Q37	4B	Q31
17	Q17	7A	Q11	17	Q38	~~2~~1A	Q6
18	Q18	17A	Q22	18	Q39	15A-a	Q19
19	Q19	15A-c	Q21	19	Q40	10B	Q37
20	(1) -	1A	Q5	20	Q41	12B	Q39
21	Q20	16B	Q44	21	(1) -	17B	Q45
22	Q21	13B	Q40	22	Q42	17B	Q45
23	Q22	17B	Q45				

(1) Computed separately for the biology curriculum specific goals.

Table 13.5: Separate correlation between items on the pilot and experimental study with their computer code numbers. For correlation between items on these two versions see Table 13.4.

Form A				Form B			
Experimental		Pilot (1)		Experimental		Pilot (2)	
Text	Computer	Text	Computer	Text	Computer	Text	Computer
1	Q1	1	Q1	1	Q23	1	Q24
2	Q2	2	Q2	2	Q24	2	Q25
3	Q3	3	Q3	3	Q25	3	Q26
4	Q4	4	Q4	4	Q26	4	Q27
5	Q5	1	Q5	5	Q27	1	Q28
6	Q6	2	Q6	6	Q28	2	Q29
7	Q7	3	Q7	7	Q29	3	Q30
8	Q8	4	Q8	8	Q30	4	Q31
9	Q9	5	Q9	9	Q31	5	Q32
10	Q10	6	Q10	10	(2)	6	Q33
11	Q11	7	Q11	11	Q32	7	Q34
12	Q12	8	Q12	12	Q33	8	Q35
13	Q13	9a	Q13	13	Q34	9	Q36
14	Q14	9b	Q14	14	Q35	10	Q37
15	Q15	10	Q15	15	Q36	11	Q38
16	Q16	11	Q16	16	Q37	12	Q39
17	Q17	12	Q17	17	Q38	13	Q40
18	Q18	13	Q18	18	Q39	14a	Q41
19	Q19	14	-	19	Q40	14b	Q42
20	(2)	15a	Q19	20	(2)	15	Q43
21	Q20	15b	Q20	21	Q41	16	Q44
22	Q21	15c	Q21	22	Q42	17	Q45
23	Q22	16	-				
		17	Q22				
		18	Q23				

(1) Only, question 1-4 Form A (or Q23-Q26,Form B) experimental correspond with Q1-4 Form A (or Q24-Q27 Form B) pilot study.

(2) Computed separately.

Once the test was prepared items were checked for item-content-congruencies and their distractors were edited by the following procedure:

1. A Ph.D. panel reviewed the test items.
2. The test items were read by experts to review any ambiguities in their content.

13.1.4 The Structure of the Field Work Achievement Test

The field work achievement test consists of a total of 42 test items. Form A with 23 test items and Form B with 22 items respectively.

The results obtained from the pilot study showed that students spend on average 20 minutes answering each test. Therefore the allocation of one class session (50 minutes) for testing provided enough time for introduction, distribution and collection of the test materials etc. In most cases, by the end of the session, all the students had finished the test and could spare a few minutes to answer questions.

The first four questions were about Van Helmont's experiments. These questions were repeated in both test forms since their importance was critical for understanding several consequent concepts and principles.

In chapter one (in the 1975 edition) these questions were adopted from B.S.C.S. Biology Teachers' Handbook (15) and were revised in the pilot study.

Questions 12, 13A and 11-12B consisted of two parallel tests. These questions were derived from chapter one and the same general objective.

There were three short-answer questions in the test: Q20A, Q10B and Q21B which were designed to measure the attainment of the first specific objective of the ecology syllabus.

Table 13.6 shows the table of specification of the test items.

Most of the items were clustered around the first two chapters which contained more concepts and principles. The few items referring to decomposers also originate from the poor treatment of this topic in the text.

Finally, the table of specification for the test items was matched with the results obtained from goal analysis of the textbook and can be justified for its details (see p.261 Appendix 2, Table 2.1).

13.2 The Sampling Design

1.0 The population of the achievement test: The first year students in secondary education were the population of test study. The age group of these students was between 14-15 years old. However, because of the high rate of drop-out at the first year (16), there were few 16 and 17 years-old students who were repeating the same course for the second or third time.

Due to the highly centralized system of education, the population was disproportionally distributed in the urban areas. So that the ten state capital cities had 50 percent of the total population. (17).

In view of the ecology curriculum, the introduction of the comprehensive education and the various revisions of the

Table 13.6: Table of specification for the field work test items.

Contents \ Outcomes	Knowledge	Comprehension	Application	Total number of items
Producers	1A, 1B, 6A, 7A, 15A, 22A, 10B.	2A, 3A, 4A, 5A, 21A, 2B, 3B, 4B, 5B.	12A, 13A, 11B, 12B.	15(1)
Consumers	10A, 19A, 20A, 17B, 20B, 18B.	6B.		7
Decomposers	23A, 21B, 22B.			3
Ecosystem	7B, 9B.	8A, 18A, 14B.	11A, 13B, 19B.	8
Population dynamics	17A.	16B.	14A, 8B.	4
Varieties of ecosystems	9A, 16A, 15B.			3
Total	21(1)	10	9	40

(1) Any items on Form A that were repeated on Form B were only counted once.

system of education in 1975 and 1976, four types of students could be identified at the first year of the secondary schools:

1. The first year students of the experimental science branch, who were studying textbook consisting of one section on ecology and another section on hygiene. (18).
2. The first year students of the comprehensive education who were studying selected chapters of the book mentioned in 1. above.
3. The first year students of the vocational education - branch hygiene - who were studying a small book on ecology and diversity of the plants and animal kingdom. (19).
4. The first year students of the humanities science who were studying a textbook consisting of identical sections on ecology as in 1. above and another section on plant and animal classification. (20).

In 1975, the above groups of students were mostly distributed in three kinds of schools: the academic, vocational and comprehensive schools. During the progress of the new system of secondary education, the above courses were further scattered amongst specialized schools. The study carried out during the field work revealed that several factors were decisive in the wide distribution of the above first year students:

1. The first factor was the unfortunate result created by the hasty implementation of the

comprehensive education. In 1975 the expansion of the comprehensive education slowed down. In 1975 many of these schools regained their old status as academic schools.

2. The second factor was the emphasis placed on the vocational and technical education in 1975 and 1976. (21). This ideology forced some academic schools to be specialized as vocational or technical schools. Therefore they had no new biology syllabus in their curricula.

3. The third factor was the high rate of drop-out at the third year of the Guidance Cycle and the first year of the secondary education. (22). This factor eliminated the numbers of the academic schools which could offer first year experimental science branch. Simply because there were not enough catch up students from their local and neighbouring schools to make them able to form a class. Therefore, most of these students had to register at the bigger schools where they created a disproportional population of the first year students at the experimental science branch. This factor, also, created specialized schools which had mainly experimental and mathematical science courses.

4. The fourth factor in distribution of the first year students was the existence of the single-sex schools. In the Iranian culture some subjects were, and still are, believed to be naturally

created for the education of girls. In the same way, technical subjects are recommended for boys. This belief is so deeply rooted in the minds of the educational administrators that is consciously or unconsciously affects their decision making on the school organization. The hygiene, for example, was a vocational subject which was thought to be suitable for girls.

The above discussion shows that although the population of the first year students could, theoretically, be scattered in a variety of schools, in practice their distribution was mostly controlled by the last two factors discussed in the third and fourth categories above.

13.2.1 The Sampling Procedure for the Achivement Test

As the result of the pilot study, it was decided to adopt the following sampling procedure for the achievement test:

1. There should be ten state capital cities in the sample. This selection was adopted for two reasons:

   Firstly, in the state capital cities the effects of the various ethnic cultures and the indigenous languages are negligible. Therefore, they do not effect the results of the achievement test. In the state capital cities there are various higher education institutes, including teachers' training institutes, which provide enough qualified teachers to teach the ecology curriculum. The existence of a university also ensures that a local in-service course could take place to up-date teachers' professional knowledge.

Secondly, the ten state capital cities provide nearly 50 percent of the total population of first year students of the experimental science branch. This facilitates the execution of the sampling design and reduces the cost of the research. (Tables 13.7 and 13.8.)

2. There should be a three-stage stratified random sampling with replacement. (23). The first stratum (stage) should be from industrialized and agricultural areas in which the diversity of the school system is of considerable interest for the present study.

   The pilot study showed that, in many schools, it is not possible to test students in the examination hall. It was decided to divide the test into two forms to prevent cheating. The use of two half tests facilitated the testing in the classroom but created another problem. This procedure halved the number of examinees in each classroom. To overcome this problem two cities were selected at random (by using the table of random numbers) from each category of the first stratum in order to double the population of the students for each half test.

3. The second stratum was schools. In each city, equal numbers of girls' and boys' schools were randomly selected. The proportion of cities

Table 13.7: The number of schools and students in the ten state capital cities in Iran selected for the biology curriculum evaluation.

Cities	No. of schools	No. of students
Ahvaz	31	2520
Isfahan	55	4455
Hamedan	8	630
Mashad	44	3555
Rasht	29	2340
Rezaiieh	18	1440
Sari	11	900
Shiraz	61	4905
Tabriz	32	2610
Tehran	319	25870
Total	608	49225

Table 13.8: The number of schools and students in the four cities randomly selected for the first stratum of the sampling design.

Cities	Schools	Students
Isfahan	55	4455
Hamedan	8	630
Rasht	29	2340
Tabriz	32	2610
Total	124	10035

chosen from each category of the first stratum, is one-fifth of the total number of the cities. The same ratio exists between the population of students in the total sample and the number of students in the four cities (see Tables 13.7 and 13.8). Therefore this ratio was applied for the selection of schools from each city.

4. The third stratum was students at the randomly selected schools. In the sampling design one-fifth of the population in each city was selected as the desired sample. This procedures, and the nature of the sample, created a stratified sampling design which is called a disproportional stratified random sample. (24). Table 13.9 summarizes the details.

Table 13.9: The details of the sampling design executed in the four state capital cities.

Cities	No. of Schools Total	Male	Female	Mixed	No. of Students Exp.Sc.	Control	Total
Isfahan	14	7	6	1	662	186	848
Hamedan	2	1	1	0	155	40	195
Rasht	13	6	7	0	521	63	584
Tabriz	12	7	5	0	635	50	685
Total	41	21	19	1	1973	339	2312

13.2.2 The Execution of the Sampling Procedure

Table 13.10 provides a comparison between the designed sample and the achieved one. (25). In column 1 the loss of the sampling for schools ~~are~~ is calculated for each city. These values range from 50 percent in Isfahan to 108.33 percent in Rasht. The mean value is 76.92 percent.

Column 2 represents the success of the sampling procedure. These values ranged from 74.30 (for Isfahan) to 128.1 percent (for Hamedan). Column 3 represents the number of students who actually took the test compared with thed expected sample. These values also represent the success of the achieved sample. These values range from 47.28 in Isfahan to 120.59 percent in Rasht. The total success in the execution is 84.04 or the raw mean value of 92.88 percent.

The above data indicated that most of the loss in the population sample was related to the number of schools designed for the study. The reasons for this loss were:

1. The factors discussed in the description of the population of sample.
2. Disproportional distribution of schools in the four cities. However, the overall loss in the population of sample is not high enough to reject the sampling procedure. The success of the sampling was calculated when the data from the achievement test was available. This data provided information for the calculation of the sampling validity.

Table 13.10: Details of the sampling and relative success of the procedure.

	Designed sample		Achieved sample		Success in execution percent.		
Cities	No. of Schools	No. of Students	No. of Schools	No. of Students	1	2	3
Isfahan	22	891	14	662	63.64	74.30	47.28
Hamedan	4	121	2	155	50.00	128.10	64.05
Rasht	12	468	13	521	108.33	111.32	120.59
Tabriz	14	522	12	635	85.71	121.64	104.25
Total	52	2002	41	1973	76.92	108.84	84.04[4]
							92.88[5]

Column 1. Schools achieved/schools designed, percent.

Column 2. Students achieved/students designed, within achieved schools, percent.

Column 3. Students achieved/students designed, percent (i.e. Col.1 x Col.2).

Number 4. Column mean

Number 5. Raw mean.

In the course of the sampling, it became necessary to adopt various strategies to achieve random sampling for the required population:

(a) In schools with one class of first year students in the experimental science branch, the whole class was tested.

(b) Where the population of the students was scattered between 2-4 classes, the whole population was tested and a minimum number of 40 students were randomly selected.

(c) Where the population was large, the required number of samples were randomly selected from the population and they were tested in a classroom.

However, in Hamedan a special problem arose. In this city, there were eight secondary schools. Two of them were Vocational and Technical schools and were eliminated from the sampling. Of the remaining six schools, four schools (one girls' school and three boys' schools) had not finished the textbook and were excluded, so the remaining two schools were used for the sampling.

Since the population of these schools (one girls' and the other boys' schools) had come from a wide area, it was assumed that replacement sampling from the same population was justified. This procedure was carried out in two other cases where the situation was similar. As the result of this procedure the number of schools on the computer programme, which actually refers to the number of samples, differed from those in Table 13.10. (See Table 13.11 below).

Table 13.11: Details of the samples used for the analysis of the biology achievement test item scores.

		Number of Students		
Category	No. of Samples	Form A	Form B	Total
Experimental group	43	926	926	1852
Control group	6	156	156	312
Whole-test group	10	292	292	584
Total	59	1374	1374	2748

13.3 Procedures for the Biology Achievement Test Validation

The criterion-referenced test item, like any other kind of test, should measure what it has been designed to assess. The prime source of validity for a CRT item is its descriptive validity. (25).

Descriptive validity or content validity is the description of the procedures and all the decisions made for the development of domains and item generation. These procedures have been described in the previous parts of this Appendix.

The functional validity is the second source of validity of the test. Functional validity can be defined as the accuracy with which a criterion-referenced test satisfies the purpose to which it is being put. (27). That is to say, the test should measure the objectives described in Section 13.1 of this report.

There are several methods for analysis and validation of the criterion-referenced test from which the following have been applied in the present study. (28).

13.3.1 Item-Objective Congruence

A good criterion-referenced test item should have item-objective congruence. This quality can be established by, (a) descriptive validity procedure and (b) by using judgemental data. Both of these procedures have been applied in the present study.

Descriptive validity of the biology test item has already been described. In the field work study, a list of the items were supplemented by a copy of the biology test forms, which were given to fifty randomly selected teachers in the four cities.

These teachers were asked to read the test items to find the correct answer. They were to decide which of the three objectives (knowledge, comprehension and application) were achieved, where their students had answered the item correctly. The actual instrument for this study can be found in Appendix 6 of this thesis. In order to prevent any ambiguity, about the definition of the abilities involved in this measurement, the three objectives were clearly defined. Results obtained from this study showed that several teachers had answered items incorrectly but rated them appropriately. These cases were omitted from the population of the sample. Therefore, the final sample was reduced from 15 to 10. Tables 13.12 and 13.13 summarize the results obtained from this group.

The procedure to analyse the results was carried out by the use of Index of Item-Objective Congruence (29), details of which has been described in Appendix 16. In this index the following formula has been used for calculating

Index of Item-Objective Congruency:

$$I_{io} = \frac{(M-1)\ S_o - S_o'}{2N(M-1)}$$

where: I_{io} = the index of congruence for item i and objective o

M = the number of objectives

N = = the number of content specialists

S_o = the sum of the rating assigned to objective o

S_o' = the sum of the rating assigned to all objectives except objective o.

This index ranges from +1 to -1 and is correct for the number of judges involved in measurement. (30).

Study of the Tables 13.12 and 13.13 showed that usually teachers had confirmed the item-objective congruence that was developed in the process of descriptive validity of the test items. This showed the test items were valid for the measurement of the attainment of the objective that they were designed to measure.

However, the degrees of agreement on the items varies from 100 percent for item 14 on the Form A to 20 percent for a few questions. The rest of the items also received a high degree of item-objective congruence. A close examination of these data showed, where the degree of agreement was low, it corresponded with disagreement on what objective the test had been designed to measure. This suggested that the following items were ambiguous:- Q13B, Q11A, Q5A and B, Q9B, and Q16B. However, results obtained from other sources (see details in the following pages) revealed that the disagreement of the teachers on the level of achievement were

Table 13.12: Item-objective congruence indices of the test items in Form A of the biology achievement test.

Item	Designed: Correct Answer	Designed: Objective	Judged by 10 Teachers: Correct Answer	Objective chosen by Judges: K[1]	Objective chosen by Judges: C[2]	Objective chosen by Judges: A[3]	1-O[4] Validity Index	Objective Chosen	% Correct Answer
Q1	B	K	B	5	1	0	.75	K	66
Q2	C	C	C	0	5	1	.75	C	58
Q3	A	C	A	0	4	1	.70	C	41
Q4	E	C	E	1	5	1	.57	C	83
Q5	C	C	C	3	2	1	.20	A,C	66
Q6	C	K	C	4	1	2	.35	K	83
Q7	C	K	C	5	1	1	.57	K	75
Q8	B	C	B	2	3	0	.40	C	50
Q9	D	K	D	2	4	1	.35	C	66
Q10	B	K	B	5	0	1	.75	K	83
Q11	E	A	E	0	3	3	.25	C,A	58
Q12	B	A	B	0	3	2	.40	C	75
Q13	A	A	A	0	3	4	.35	A	83
Q14	C	A	C	0	0	5	1.00	A	41
Q15	C	K	C	4	2	2	.25	K	83
Q16	B	K	B	7	0	1	.81	K	83
Q17	A	K	A	6	1	1	.62	K	83
Q18	B	C	B	0	2	6	.62	C	83
Q19	D	K	D	6	1	1	.62	K	83
Q20	-	K	-	4	1	0	.70	K	
Q21	D	C	D	2	2	3	.25	C	91
Q22	A	K	A	3	2	1	.29	K	75
Q23	B	K	B	1	1	5	.57	C	58

Table 13.13: Item-objective congruence of the test items in Form B of the biology achievement test.

Item	Designed		Judged by 10 Teachers						
	Correct Answer	Objective	Correct Answer	Objective chosen by Judges			1-0 Validity Index	Objective Chosen	% Correct Answer
Q1	B	K	B	5	1	0	.75	K	58
Q2	C	C	C	0	5	1	.75	C	58
Q3	A	C	A	0	4	1	.70	C	50
Q4	E	C	E	1	5	1	.57	C	83
Q5	C	C	C	3	2	1	.20	A,C	66
Q6	B	C	B,C	0	1	3	.62	A	50
Q7	D	K	D,C	6	1	0	.78	K	50
Q8	B	A	B	4	0	1	.70	K	58
Q9	D	K	D	3	0	3	.25	K,A	75
Q10	-	K	-	4	1	0	.70	K	100
Q11	C	A	C	0	0	8	1.00	A	75
Q12	D	A	D	0	1	7	.81	A	83
Q13	A	A	A	1	4	3	.25	C,A	66
Q14	C,D	C	C,D	2	1	1	.25	K	50
Q15	E	K	E	6	1	1	.62	K	91
Q16	D	C	D	3	3	1	.25	K,C	75
Q17	E	K	E	4	2	1	.35	K	91
Q18	A	K	A	6	1	0	.64	K	91
Q19	B	A	B	1	2	5	.43	A	91
Q20	D	K	D	4	3	0	.35	K	83
Q21	-	K	-	4	0	1	.70	K	100
Q22	C	K	C	8	0	0	1.00	K	83

due to their different treatment of the textbook rather than the intrinsic ambiguity of the test items.

In two cases the teachers chose two distractors as the correct answer, i.e. Q6B and Q7B but agreed that the test had item-objective congruence. This suggested that these questions should be examined for the ambiguities of their distractors but interviews with the students and teachers showed that this ambiguity had been caused by differences in the 1975 and 1976 editions of the text. The item-objective congruency process not only provided information for the validity of the test. It also described the source of ambiguity in the item for item improvement.

13.3.2 Sensitivity to Instruction

A good criterion-referenced test should be sensitive to the effects of the instruction. Sensitivity to instruction was computed from comparison between response data obtained from two groups of students: a group of students who had been exposed to the instruction and another group who had not.

In the course of the field work students with identical age groups and background to those of the first year of the academic secondary education, were randomly selected from the vocational schools as the control group. These students had no biology in their vocational curricula and were housed in separate schools, usually located in the city outskirts. Therefore, the degree of contamination between the two groups was very small.

A discriminant analysis technique was to compare scores obtained for each item from the two groups. Details of the discriminant analysis programme can be found in Appendix 18. In Tables 13.14 and 13.15 overall comparisons between the two groups are shown. These results showed that the two test forms were highly discriminant amongst the groups. They were significantly sensitive to the instruction since they were designed to assess its effects.

Details of the discriminant analysis revealed that different items on the test forms showed different degrees of sensitivity towards the instruction. These results can be found on the first column of Table 13.16. The numbers of the test items corresponds with their numbers on the computer programme used for the analysis of the tests. In this analysis item No.20A, 10B and 21B were omitted and analysed separately (see Section 13.4.1 of this report). Immediately, it could be seen that item No.5A and its identical item No.27 on the Form B, and item No.14A were not discriminant. The reason originates from the item difficulty. These items were difficult for experimental groups since the details in the 1976 edition of the textbook were not clear in describing concepts involved. In many cases, teachers and students used to ask about the right answer to this question. However, when the concepts were understood or the answer was known, the item received a high degree of agreement on its item-objective congruency. The mean value for these items were 0.18 and .10 for the Form A and 0.17 and 0.14 for Form B for the experimental and control groups respectively. Therefore, the answer obtained may have been

Table 13.14: Form A, Discriminant Analysis between experimental and control group.

Actual Group		Number of Cases	Predicted Group Membership	
Name	Code		Experimental	Control
Experi.	1	926	870 94.0 PCT	56 6.0 PCT
Control	2	156	43 27 PCT	113 72 PCT

90.9 percent of known cases correctly classified
Chi-square = 722.23 Significance = 0

Table 13.15: Form B, Discriminant Analysis between experimental and control group.

Actual Group		Number of Cases	Predicted Group Membership	
Name	Code		Experimental	Control
Experi.	1	926	871 94.1 PCT	55 5.9 PCT
Control	*	156	30 19.2 PCT	126 80.8 PCT

92.1 percent of known cases correctly classified
Chi-square = 768.71 Significance = 0

Table 13.16: Discriminant analysis between experimental and control group. Analysis of variance between boys/girls, industrialized and agricultural areas. (1) For significant level of Columns II and III see description in the text.

Form A				Form B			
Item	F I Exp/Con	F II Boys/Girls	F III Area 1/Area 2	Item	F I Exp/Con	F II Boys/Girls	F III Area 1/Area 2
Q1	28.2	3.4	0.0	Q23	22.3	4.5	0.8
Q2	68.6	8.7	5.7	Q24	69.4	0.2	0.3
Q3	9.8	2.8	0.3	Q25	3.8	11.9	1.0
Q4	104.	2.0	0.0	Q26	105.	6.6	0.1
Q5	6.6	0.0	1.8	Q27	0.6	1.3	0.8
Q6	149.	5.0	5.1	Q28	49.4	6.0	0.2
Q7	46.7	12.3	5.8	Q29	205	7.0	0.0
Q8	28.9	15.5	2.6	Q30	21.2	1.8	6.6
Q9	15.7	5.1	16.0	Q31	254.4	0.0	0.0
Q10	76.7	0.0	6.7	Q32	40.5	1.3	3.9
Q11	42.2	3.3	0.4	Q33	154.6	.4	2.1
Q12	166.	7.0	0.9	Q34	50.4	4.9	1.3
Q13	125.	6.4	1.3	Q35	15.3	1.8	2.2
Q14	0.0	0.0	2.4	Q36	21.5	10.4	25.3
Q15	47.8	0.0	0.6	Q37	91.3	0.2	2.1
Q16	52.0	0.7	1.8	Q38	134.	1.0	7.4
Q17	103.	10.2	15.4	Q39	65.1	0.3	5.5
Q18	20.5	6.4	0.5	Q40	7.8	0.4	0.8
Q19	72.7	2.7	0.2	Q41	145	8.9	0.9
Q20	121.	4.8	1.1	Q42	31.5	2.7	1.9
Q21	3.6	1.1	1.9				
Q22	0.8	1.0	8.2				

(1) The number of the items corresponds with the code numbers on the computer programme. $F \geqslant 6.6$ for $p \leqslant .01$

obtained partly by random guessing of the distractor which had caused similar variance for both groups on the two test forms (S.D. was 0.38 and 0.30, 0.37 and 0.35 respectively).

The case of item No.14A held different story. This item was achieved similarly by both the groups (mean for experimental group = 0.35 and control group = 0.35, S.D. = 0.4 7 and 0.47 respectively). A close examination of the item, and the results of the interviews with students of both groups, revealed that the meaning of the biotic factor given in the parenthesis, for the distractor C, had guided some individuals in the control group to choose it as the right answer. The score from experimental group, however, was a mixture of the true response and semantic interpretation of the distractor involved.

It is therefore concluded that this additional information was the cause of the low sensitivity of the item. This conclusion suggested that item No.14 should be corrected for the flaw in its distractors.

13.3.3 Test Bias - A good Criterion-referenced test item should not be biased for sex or culture

It was assumed, at the beginning of this chapter, that students in all schools throughout the country were studying the same textbooks. Therefore, their achievements were expected to be the same for the items in the test forms. It could be further argued that the test forms should not discriminate between sexes or students from different areas. In the process of the sampling procedure it was assumed that if the conditions in industrialized and agricultural areas were different this should affect the results of the biology achievement tests.

Within sample groups there were various kinds of instructions, originating from the way teachers used their materials. Therefore, variance from scores of the test items were inevitable. The existence of this variance justified the application of classical test theory model statistics for the interpretation of the test bias.

T-Test and Anova were two appropriate statistical techniques for the analysis of the effects of independent variables on the results of the biology test scores. Details of these techniques and their underlying assumptions have been described in Appendix 18.

The results obtained from the T-Test analysis of the effect of the independent variables on the test scores, revealed that the two biology test forms did not discriminate between sexes. They were not biased for sex (Table 13.17). However, the same analysis showed teachers' tests were highly biased for boys and girls (Table 13.18a, b). Further description of these differences will be discussed in the general discussion of the achievement test results.

The analysis of variance (Anova) revealed that although the two tests were not biased for either sex, nor for areas or cities, Form A of the achievement test was sex biased in City 2 (Tabriz) which had been caused by variance of certain items in the Form A (see Table 13.16). Detailed analysis of variance for all the test items showed the above reasons originated from a few questions in the Form A. Table 13.16

Table 13.17: Results of the analysis of variance between scores of the two test forms and various independent variables.

Independent variables	Test form	Number of cases	F	Significant of F
Sex (Area 1)	Form A	603	9.65	0.00
	Form B	603	4.37	0.03
Area 1 (Cities)	Form A	603	0.00	0.97
	Form B	603	0.48	0.48
Sex: City 1	Form A	298	1.30	0.25
	Form B	298	2.12	0.14
Sex: City 2	Form A	305	10.50	0.00
	Form B	305	2.21	0.13
Sex: City 3	Form A	76	1.10	0.29
	Form B	76	0.04	0.83
Sex: City 4	Form A	247	2.51	0.11
	Form B	247	0.00	0.96
Area 2 (Cities)	Form A	323	0.80	0.37
	Form B	323	0.62	0.43
Sex (Area 2)	Form A	323	0.65	0.41
	Form B	323	0.28	0.25

$p \leqslant 0.01$

Table 13.18a: T-Test and the comparison between boys' and girls' achievement.

Test	Sex	N	M	S.D.	S.E.	F	2-Tail Prob.	t	D.f.	2-Tail Prob.
Q43	Boys	532	9.75	3.24	.14	1.04	.68	-2.31	816	.02
	Girls	384	10.26	3.21	.16					
Q44	Boys	532	9.21	3.29	.14	1.32	.00	-1.59	882	.11
	Girls	384	9.54	2.86	.14					
Q46	Boys	425	14.54	3.11	.15	1.02	.83	-5.71	635	.00
	Girls	306	15.88	3.14	.18					
Q47	Boys	421	14.78	2.77	.13	1.07	.50	-5.11	599	.00
	Girls	287	15.89	2.87	.17					
Q48	Boys	413	14.62	3.15	.15	1.11	.34	-7.28	670	.00
	Girls	304	16.31	3.00	.17					
Q49	Boys	409	14.90	2.64	.13	1.13	.24	-5.80	602	.00
	Girls	292	16.12	2.81	.16					

$p \leqslant 0.01$

Q43 = Form A, total right scores.
Q44 = Form B, total right scores.
Q46 = Form A group, first term examination mark.
Q47 = Form A group, second term examination mark.
Q48 = Form B group, first term examination mark.
Q49 = Form B group, second term examination mark.

Table 13.18b: Comparison between students' achievement in industrialized and agricultural areas.

Test	Area	N	M	S.D.	S.E.	F	2-Tail Prob.	t	D.f.	2-Tail Prob.
Q43	Indus.	603	10.18	3.40	.13	1.30	0.00	2.90	736	0.00
	Agri.	323	9.55	2.98	.16					
Q44	Indus.	603	9.38	3.01	.12	1.22	0.04	0.37	605	0.70
	Agri.	323	9.30	3.32	.18					
Q46	Indus.	507	15.07	3.09	.13	1.19	.11	-0.30	419	0.76
	Agri.	234	15.15	3.38	.22					
Q47	Indus.	489	15.21	2.81	.12	1.11	0.35	-0.52	425	0.60
	Agri.	229	15.33	2.96	.19					
Q48	Indus.	494	15.36	3.01	.13	1.42	0.00	0.35	391	0.72
	Agri.	233	15.26	3.58	.23					
Q49	Indus.	481	15.32	2.79	.12	1.03	0.83	-1.49	456	0.13
	Agri.	230	15.62	2.75	.18					

$p \leqslant 0.01$

Q43 = Form A, total right scores.
Q44 = Form B, total right scores.
Q46 = Form A group, first term examination mark.
Q47 = FormmA group, second term examination mark.
Q48 = Form B group, first term examination mark.
Q49 = Form B group, second term examination mark.

Table 13.18c: Analysis of variance between schools for the scores obtained from individual test items.

Item	F	Significant level	Item	F	Significant level
Q1	4.52	.00	Q23	4.78	.00
Q2	2.04	.00	Q24	1.62	.00
Q3	3.13	.00	Q25	2.62	.00
Q4	2.13	.00	Q26	1.88	.00
Q5	1.02	.42	Q27	1.91	.00
Q6	1.19	.18	Q28	1.51	.01
Q7	3.04	.00	Q29	1.50	.02
Q8	2.00	.00	Q30	2.04	.00
Q9	3.40	.00	Q31	2.67	.00
Q10	4.14	.00	Q32	1.37	.05
Q11	1.67	.00	Q33	2.21	.00
Q12	1.74	.00	Q34	1.82	.00
Q13	2.03	.00	Q35	2.04	.00
Q14	1.68	.00	Q36	3.69	.00
Q15	3.55	.00	Q37	1.68	.00
Q16	2.51	.00	Q38	2.28	.00
Q17	2.80	.00	Q39	3.75	.00
Q18	1.62	.00	Q40	1.46	.03
Q19	2.70	.00	Q41	3.12	.00
Q20	2.15	.00	Q42	2.12	.00
Q21	1.15	.23			
Q22	1.01	.45			

$p \leqslant 0.01$

Columns II and III correspond with the results obtained from analysis of variance for the effects of the sexes and areas on individual test item scores.

As is discussed later in this report, the results were not created from the intrinsic quality of the test items but should be attributed to the effects of difference in instructions used in the population of 43 schools. The variance resulted from different treatment of concepts and principles by different teachers were reflected in the item score and hence the test bias. There are other factors responsible for discrepancies of the results that will be discussed in later parts of this chapter.

On the whole it can be concluded that, except for a few items of the test, the test forms were not biased for the sexes or areas involved in the sampling to the extent of the teachers' test. This showed that in spite of the difference between various factors in the industrialized and agricultural areas the difference between the achievement of students was due to the difference in instructions (Table 13.18c).

13.3.4 Equivalence or Internal Consistency

Test equivalence measures the homogeneity of test items for an objective - that is, how coherently the test items assess a test or a particular objective. (17)

Internal consistency of the whole test can be measured by the use of reliability coefficient, i.e. coefficient alpha. In a test with correct or wrong scoring procedure, coefficient alpha, Kuder-Richardson's formula 20 and 21 and Hoyt's reliability coefficient provide identical results (Table 13.19a). (31).

The existence of a low variance in the biology criterion-referenced test items scores justified the application of classical test theory reliability coefficient for the measurement of internal consistency of the whole test. Table 13.19b shows the procedure of measuring reliability of the whole-test group scores. The low value of reliability $r_{tt} = .67$ in this case and in those of the test forms for the field work groups suggested that the variance of the item scores was not very high. The examination of the discriminant indices on Table 13.19b shows that the reason should be sought in the low discrimination of the items which were characteristic of the CRT items.

Internal consistency of the CRT items can be interpreted either, (a) in terms of the score stability of items from the same objective that are consistent in their scores when they were used on two occasions by the same group of students. The underlying assumption in this case is that there should be no intervention, i.e. instruction, in the time between the two administrations of the test items. Or (b) parallel test items and items derived to measure the same objective should also have stability in their scores.

The measurement of stability provided some evidence for validity of the test construction (32). It justified the procedure of descriptive validity and the procedure applied for item generation and item selection.

In the sampling procedure a whole test group was established. This group of students tried both test forms.

Table 13.19a: Reliability between test-retest and parallel test items.

	Q1/Q23	Q2/Q24	Q3/Q25	Q4/Q26	Q5/Q27	Q12/Q13	Q32/Q33
Reliability	.72	.63	.72	.71	.65	.80	.33(1)

(1) The low reliability resulted from flaws in the distractor of test item No.32.

Table 13.19b: Whole Test Group: reliability analysis.

Item-Total Statistics	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q1	18.76027	23.90797	.08834	.39478	.67397
Q2	18.49658	23.19930	.21636	.34541	.66553
Q3	18.91096	24.02641	.11230	.39308	.67177
Q4	18.23288	23.42325	.23256	.41854	.66512
Q5	18.85959	24.21046	.03705	.33880	.67600
Q6	18.16096	23.66129	.21824	.20050	.66665
Q7	18.71575	22.69212	.35679	.28674	.65600
Q8	18.75342	23.45789	.19138	.17415	.66737
Q9	18.55137	23.41660	.17001	.19933	.66890
Q10	18.71233	23.11971	.25690	.26945	.66288
Q11	18.48288	23.58390	.13589	.13998	.67134
Q12	18.29452	22.80643	.35324	.49502	.65687
Q13	18.25342	23.15892	.28870	.53021	.66154
Q14	18.70548	24.16726	.02231	.12542	.67868
Q15	18.61301	23.18650	.22276	.24194	.66508
Q16	18.38014	23.50105	.16442	.19633	.66920
Q17	18.53767	23.68586	.11360	.15808	.67296
Q18	18.33219	23.82398	.10145	.20066	.67330
Q19	18.44863	23.03172	.25615	.26502	.66266
Q20	18.56507	23.14008	.22896	.23721	.66461
Q21	18.93151	24.52450	-.04172	.11467	.67827
Q22	18.93836	24.50478	-.03430	.10599	.67776
Q23	18.77740	23.87811	.09922	.40854	.67318
Q24	18.47603	22.95131	.27071	.33283	.66156
Q25	18.88699	23.81880	.15974	.41995	.66945
Q26	18.26027	23.25161	.26130	.49273	.66315
Q27	18.83562	23.93852	.10149	.32994	.67269
Q28	18.81507	23.64266	.16920	.30477	.66881

/continued..

Table 13.19b (continued)

Item-Total Statistics	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
Q29	18.35959	23.93554	.07242	.14791	.67538
Q30	18.59589	23.74679	.10270	.12178	.67368
Q31	18.36301	22.93306	.29538	.22066	.66015
Q32	18.59247	23.44503	.16587	.20649	.66918
Q33	18.38356	22.75959	.32884	.21893	.65766
Q34	18.73630	23.26699	.23041	.20341	.66476
Q35	18.91438	24.00295	.12206	.16485	.67131
Q36	18.60959	23.96389	.05822	.19070	.67678
Q37	18.25685	24.30837	.00158	.11645	.67880
Q38	18.28767	23.47710	.19378	.18289	.66724
Q39	18.71233	22.89291	.30895	.32965	.65929
Q40	18.71918	23.73530	.11943	.16821	.67216
Q41	18.55137	22.39941	.38857	.33026	.65273
Q42	18.49315	23.42607	.16857	.14121	.66900

A value of 99.0 is printed if a coefficient cannot be computed.

Reliability coefficients 42 items

Alpha = .67363 Standardized item alpha = .66329

Therefore several test forms were retested (Items 1A-5A and 1B-5B). The parallel test on both test forms were tried by the whole group so that items from the same objectives which have been dispersed in the two test forms were tried by the same individuals.

In the procedure of establishing for test-retest, each class was divided into two randomly selected groups. Each group tried each of the different tests in each testing occasion.

There are two simple ways to examine the stability and consistency of the test item scores from the same objectives. One technique was the correlational technique in which scores obtained from each individual item was compared with others that have been either derived from the same objectives or other domains. The second technique was a simple comparing the percentages of scores obtained from identical test items on the two occasions. (33).

Table 13.20 is the result of the correlational technique~~s~~ that was applied on the test items. The significant level for each correlation coefficient value was determined by t-test and the use of two-tail table of significant level of the t value (see Appendix 18 for more details of this procedure).

A close examination of the results showed that:

1. Items derived from the same domain or general objective are highly correlated and have significance level of 0.001. In Table 13.20, in order to distinguish these two sets of items, they were underlined by two lines. The one

Table 13.20: Whole-test group. Correlation between 42 test items. N = 292

	1B=23	7A	20B-41					
	r=.56	.13	.15					
1A								
	s=.001	.02	.007					
	2B=24	4B=26	4A	7A				
	r=.46	.24	.23	.14				
2A								
	s=.001	.001	.001	.01				
	3B=25	20B=41						
	4=.56	.13						
3A								
	s=.001	.02						
	4B=26	7A	9A	6A	12A	12B=33	2B=24	19B=40
	r=.55	.13	.15	.18	.14	.11	.13	.15
4A								
	s=001	.01	.007	.001	.01	.05	.02	.008
	5B=27	19B=40						
	r=.48	.12						
5A								
	s=001	.03						
	4A	7A	4B=26	6B=28	12B=33			
	r=18	.15	.24	.15	.14			
6A								
	s=001	.009	,001	.009	.01			
	2A	6A	10A	1B=23	6B=28	12B=33	17B=38	19B=40
	r=.14	.15	.15	.11	.28	.13	.16	.11
7A								
	s=01	.009	.009	.05	.001	.02	.005	.04
	20B=41	22B=42						
	r=.29	.17						
	s=.001	.003						

/continued..

Table 13.20 (continued)

	7A	21A=20	5B=27	6B=28	17B=39	18B=39	19B=40	20B=41
8A	r=.23	.12	-.13	.13	.13	.11	.16	.12
	s=001	.03	.02	.01	.01	.04	.006	.03
	4A	16A	6B=28					
9A	r=.15	.25	-.13					
	s=.007	.001	.01					
	19A	21A=20	9B=31	12B=33	14B=35	18B=39		
10A	r=.20	.18	.18	.13	.16	.36		
	s=.001	.001	.001	.02	.005	.001		
	12A	13A	21A=20	14B=35				
11A	r=.14	.15	.15	.15				
	s=.01	.006	.007	.007				
	4A	11A	13A	9B=31	12B=33	18B=39	20B=41	
12A	r=.14	.14	.67	.17	.17	.14	.16	
	s=.01	.01	.001	.003	.002	.01	.004	
	12A	11A	9B=31	12B=33	15B	20B=41	22B=42	
13A	r=.67	.15	.14	.17	-.16	.16	.11	
	s=.001	.006	.01	.003	.006	.004	.05	
	9B=31							
14A	4=.11							
	s=.04							
	12A	13A	14A	18A	20A=21	1B=23	9B=31	
15A	r=17	.20	.12	.12	.18	-.12	.22	
	s=.02	.001	.03	.03	.002	.03	.001	

/continued..

Table 13.20 (continued)

	11B=33	12B=34	20B=41				
	.17	.15	.14				
	.003	.009	.01				
	9A	12A	13A	22B=42			
	r=.25	.13	.14	.12			
16A							
	s=.001	.02	.01	.03			
	18A	19A	2B=24				
	r=.14	.14	.18				
17A							
	s=.01	.01	.002				
	12A	13A	14A	15A	17A	6B=28	
	r=.16	.20	.12	.14	.14	-.16	
18A							
	s=.004	.001	.03	.01	.01	.005	
	2A	4A	6A	10A	12A	13A	
	r=14	.16	.12	.20	.12	.13	
19A							
	s=01	.006	.03	.001	.03	.02	
	17A	4B=26	18B=39	20B=41			
	r=.14	.23	.26	.21			
	2=.01	.001	.001	.001			
	7A	8A	10A	11A	12A	13A	6B=28
	r=.19	.12	.18	.15	.10	.13	.19
21A=20							
	s=.001	.03	.001	.007	.06	.02	.001
	8B=30	9B=31	14B=35	17B=38	18B=39	20B=41	
	r=.13	.13	.13	.14	.12	.21	
	s=.02	.02	.02	.01	.02	.001	
22A=21	-						
23A=22	-						

/continued..

Table 13.20 (continued)

	1A	07	20B=41						
	r=.56	.11	.11						
1B=23									
	s=.001	.05	.04						
	2A	4A	4B=26						
	r=.46	.13	.24						
2B=24									
	s=.001	.02	.001						
	3A	20B=41							
	r=-.56	.19							
3B=25									
	s=.001	.001							
	2A	4A	6A	10A	19A	2B=24	13B=34	14B=35	19B=40
	r=.24	.55	.24	.12	.23	.24	.12	-.13	.17
4B=26									
	s=.001	.001	.001	.02	.001	.001	.04	.02	.003
	5A	1A							
	r=.48	.56							
5B=27									
	s=.001	.001							
	6A	8A	18A	20A	18B=39	20B=41			
	r=.15	-.13	-.16	.19	.14	.22			
6B=28									
	s=.009	.02	.005	.001	.01	.001			
	16B=37								
	r=-.13								
7B=29									
	s=.02								
	.20B=41								
	r=.12								
8B=30									
	s=.03								

/continued..

Table 13.20 (continued)

9B=31	10A r=.18 s=.001	12A .17 .003	13A .14 .01	14A .11 .04	15A .22 .001	21A=20 .13 .02	18B=33 .25 .001	13B=34 .18 .002
	14B=35 r=.16 s=.005	17B=38 .11 .04						
11B=32	5A r=-.16 s=.005	15 .13 .02	12B=33 .20 .001	14B=35 .13 .02	15B=36 .15 .008	17B=38 .17 .003		
12B=33	6A r=.14 s=.01	9A .12 .04	10A .13 .02	12A .17 .002	13A .17 .003	15A .17 .003	2B=24 .11 .04	9B=31 .25 .001
	11B=32 r=.20 s=.001	13B=34 .13 .02	15B=36 .12 .03	18B=39 .18 .002	20B=41 .13 .02			
13B=34	15A r=.15 s=.009	2B=24 .14 .01	4B=26 .12 .04	5B=27 .11 .04	9B=31 .18 .002	12B=33 .13 .02	16B=37 .13 .02	
	18B=39 r=.17 s=.003	19B=40 .13 .02						
14B=35	10A r=.16 s=.005	11A .15 .007	21A=20 .13 .02	4B=26 -.13 .02	9B=31 .16 .005	11B=32 .13 .02		

/continued..

Table 13.20 (continued)

	6A	13A	11B=32	12B=33					
15B=36	r=.16	-.16	.15	.12					
	s=.005	.006	.008	.03					
	29	13B=34							
16B=37	r=-.13	.13							
	s=.02	.02							
	8A	6B=28	9B=31	11B=32	13B=34	18B=39	20B=41		
17B=38	r=.13	.15	.11	.17	.17	.13	.21		
	s=.01	.008	.04	.003	.003	.02	.001		
	7A	8A	10A	11A	19A	6B=28	12B=33	13B=34	
18B=39	r=.15	.11	.36	.14	.26	.14	.18	.17	
	s=.009	.04	.001	.01	.001	.01	.002	.003	
	17B=38	19B=40	20B=41						
	r=.13	.11	.28						
	s=.02	.05	.001						
	4A	7A	8A	4B=26	13B=34				
19B=40	r=.15	.11	.16	.17	.13				
	s=.008	.04	.006	.003	.02				
	1A	3A	7A	12	13	15	21A=20	1B=23	3B=25
20B=41	r=.15	.13	.29	.16	.16	.14	.21	.11	.19
	s=.007	.02	.001	.004	.004	.01	.001	.04	.001
	6B=28	8B=30	12B=33	17B=38	18B=39				
	r=.22	.12	.13	.21	.28				
	s=.001	.03	.02	.001	.001				
	7A	13A	16A	1B=23	6B=28				
22B=42	r=.17	.11	.12	.12	.13				
	s=.003	.05	.03	.02	.02				

line means the casual correlation. In this Table only those correlation coefficients with a significant level $\leq$ 0.05 percent were registered.

2. The retest items, i.e. items 1A-5A and 1B-5B, had a high correlation coefficient and reliability value at significant level of .001 percent.
3. Parallel items or items in questions 12A and 12B, 11B and 12B (32 and 33 on the computer programme) were also highly correlated.

The overall interpretation of the result suggested that the correlation between various items followed the pattern of item specification on Table 13.6. Those items with the same facility level of cognitive attainment, and from the same domain, were more correlated with each other than those with different level of cognitive attainments.

13.3.5 Criterion Validity

Criterion validity of the CRT is defined as the quality of the test item to differentiate between those who mastered the task involved and those who did not. There are two sources of evidence for criterion validity of the biology achievement test:

1. Item Validity: A good criterion-referenced test item should discriminate between those who achieved mastery and those who did not. This quality can be measured by CRT discriminant index (34) or vs index (vs stands for item validity for measure of state). (35). Details of both can be found in Appendix 18.

The vs index was used to measure validity of the test items. This index has the following formula:

$$vs = (c_u/n_u) - (c_l/n_l)$$

where vs = index of item validity for measure of state.

c_u = the number of students who passed the mastery cut-off score and got the item right.

c_l = the number of students who failed the mastery cut-off score but got the item right.

n_u = the total number of students who passed the mastery cut-off score.

n_l = total number of students who failed the mastery cut-off score.

The value of vs index varies from -1 to +1. The ideal value of vs is zero. A positive, and certain negatively discriminating items, indicate that either item or instruction may require revision.

This index has similarity with discriminant index and has the same function for CRT items. (36).

The results in Table 13.21 showed that those items which had been achieved by all schools had a very low discrimination value. Items with high discrimination value contributed to those items which had not been achieved equally by all teachers in all 43 schools. This result suggests that

Table 13.21: Results obtained from computation of index of item validity as a measure of state.

Question	c_u	n_u	c_l	n_l	c_u/n_u	c_l/n_l	vs
Form A Q1	130	288	130	638	.45	.20	.25
Q2	184	288	253	638	.63	.39	.24
Q3	78	288	70	638	.27	.10	.17
Q4	258	288	448	638	.89	.70	.19
Q5	81	288	92	638	.28	.14	.14
Q6	277	288	521	638	.96	.80	.16
Q7	163	288	115	638	.56	.18	.38
Q8	146	288	184	638	.50	.28	.22
Q9	176	288	196	638	.61	.30	.31
Q10	184	288	172	638	.63	.26	.37
Q11	197	288	272	638	.69	.42	.27
Q12	264	288	357	638	.91	.55	.36
Q13	260	288	348	638	.90	.54	.36
Q14	138	288	189	638	.47	.29	.18
Q15	176	288	205	638	.60	.32	.28
Q16	229	288	285	638	.79	.44	.35
Q17	224	288	272	638	.77	.42	.35
Q18	253	288	442	638	.88	.69	.19
Q19	243	288	334	638	.84	.52	.32
Q20	217	288	279	638	.75	.43	.32
Q21	40	288	40	638	.13	.06	.07
Q22	35	288	51	638	.12	.07	.05
Q23	100	223	143	703	.44	.20	.24
Q24	161	223	278	703	.72	.25	.47
Q25	69	223	54	703	.30	.07	.23
Q26	194	223	505	703	.87	.71	.16
Q27	59	223	110	703	.26	.15	.11
Q28	102	223	99	703	.45	.14	.31
Q29	195	223	491	703	.89	.69	.20
Q30	149	223	319	703	.66	.45	.21
Q31	205	223	421	703	.91	.59	.32
Q32	147	223	272	703	.65	.38	.27
Q33	208	223	395	703	.93	.56	.37

Table 13.21 (continued)

Question	c_u	n_u	c_l	n_l	c_u/n_u	c_l/n_l	vs
Q34	123	223	184	703	.55	.26	.29
Q35	75	223	77	703	.33	.10	.23
Q36	146	223	261	703	.65	.37	.28
Q37	186	223	534	703	.83	.75	.08
Q38	214	223	491	703	.95	.69	.26
Q39	145	223	212	703	.65	.30	.35
Q40	120	223	212	703	.53	.30	.23
Q41	195	223	336	703	.84	.47	.37
Q42	154	223	317	703	.69	.45	.24

although all schools had a single textbook as the source of learning and instruction, they differed in the way teachers had used the curriculum materials and which edition of the textbook they had used.

2. Item Mastery: The second source of criterion validity can be derived from examination of the scores obtained from individual schools. A good CRT item should be achieved by masters and missed by non masters. If 60% (equivalent to 12/20 Iranian pass mark) cut-off score could be chosen as the criterion for item mastery, then we can examine individual schools for total objectives mastered. Figure 13.20 shows results obtained from 43 schools.

Items on a CRT should discriminate between those who passed the mastery cut-off score and those who did not. In the majority of the schools items were either passed well above 60% of cut-off score or missed by more than 80% of the students. These results proved that the test items, which had an average of low variance in the whole population of students had a very low or no variance in the population of individual schools. The existence of less than 20% pass by some individual schools was the result of factors like the difference in the details of the instructional materials or instructions.

Interviews with students and the teacher revealed that in schools where an item was answered correctly by less than 20% of the whole class they had either:

(a) Two different teachers taught at different times in the academic year.

(b) Students were using different editions of the textbook which gave different details about the items in question. Their answers had revealed other reasons for the low variability of the test scores for the whole population besides that of differences in instruction.

13.4 General Discussion of the Results

Most of the data obtained from experimental, control and whole-test groups can be found in Tables 13.23 to 13.29 respectively. The following discussion is based on these data and those that have been derived from other sources.

The ecology test consisted of 45 test items, 42 of them were analysed by a computer and the other three, which were concerned with specific objectives, were treated differently. The first question in analysis is "Has the test measured the biology curriculum objectives?" This question can be further analysed into three specific questions?

1. Have the specific objectives of the ecology curriculum been achieved?
2. Have the textbook objectives been achieved?
3. Have the biology curriculum objectives been achieved?

13.4.1 Ecology Specific Objectives

Items 20A, 10B and 21B were short-answered questions asking students to name two different types of producers, consumers and decomposers respectively.

It was assumed that if students had become familiar with varieties of living creatures and had carried out activities suggested in the text, then they could suggest divergent types of living organisms. On the other hand, if instruction had been limited to rote learning of the text most of the answers should cluster around the name of few organisms that had been repeatedly mentioned in the content of the textbook. The results from the control group could also provide a criteria for comparison between responses obtained from the two groups.

Table 13.22 shows the results obtained from the experimental groups. The control group had no correct responses for the items 20A and 21B but some had answered the item 10B correctly. However, interviews with these students showed that they did not know the concept of consumers in biological terms but deduced the meaning as it could refer to living creatures that consume something.

At the achievement level, most schools had a total score well above 60% cut-off score. The distribution of scores amongst various organisms named by the whole population was the most interesting pattern in their responses.

They named 56 different kinds of producers, 75 consumers and only 6 decomposers. For Item 20A most of the response were clustered around five animals:

Name of consumer	Relative frequency (average number of students choosing that name in each school)
Man	7.8
Rabbit	5.8
Fox	4.4
Sheep	3.4
Cow	2.9

These were the most common names in the textbook. The other popular names were cat, lion, wolf, zoo plankton and mouse, which had a relative frequency of less than 1.8 by students in each school.

For item 10B, the responses clustered mostly around the term "green plants" (11.2). The few other producers like phytoplankton (1.4), geranium (1.4), green algae (1.4), algae (1.2), iron bacteria (1.1), sulphur bacteria (1.2) apple (1.2) and chemosynthetic organism (.8) had relatively low average response from students in each school.

The choice for decomposer was limited to the term bacteria (13.1), bread mould (4.8), mould (5.3) and mushroom (1.7). Virus and yeast were the only other names mentioned by a few schools.

These results showed that although the status of man in the ecosystem as a consumer has been understood by most of the students (objective No.2), understanding of the diversity of living organisms have not been achieved to the

Table 13.22: Raw data obtained from item 10b.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Animal		1	2	2	1	1				1	1			1	1		1	1	1	1	1		1			3	1	1	4		1					1	1			1	1				
Ant					1										1				1			1		1																			1		
Aphid		2			1				1		1												1	1						1					1						2	1			
Bacteria																			1	1		1	2				1	2	1			1			1			1							
Bear					1	1		3		1	1								1								1													1	2				
Bread mould	1							1						2					1								1									1				1	3				
Butterfly					1				1												2																						1		
B. Larvi							2		1	1				1	1									3										2	1						1				
Bird	1		1					1				1										1																							
Camel								1	1						1																														
Carnivour			2	2				1	1													1	1								1								1		1				
Cat	3			2			2	4		2				2	1	1		2	2	1		1		1	2	6		1		1	1			1		1	2		1						
Cicada																																													
Coral																				1		1															1								
Cow		2	2	5	1	2	2			2	5	3		6	2	5	4	2	1		4	7		7	5	1	3	1	2	1	8			6	3	1	3	2	4	3	5	6	8		
Crow																								1																					
Decomposer																											1													1		1			
Deer									1					1								1						1											1	1					
Dog	1	1		1		1	1			1				2	1			3	3	1			2	1	2	3													1	1					
Donkey								2	1					1	1	4		1	1																		2	2							
Eagle	1			1		1				1				1	2	2	1					2			1					2	1			2			2	2					1		
Earthworm		1																	1																				1						
Elephant									1									1											1		1				1		1		2		1	1	1		
Falcon						1			1		1			1	1		2	1		3			1				1		2	1				2	1										
Fish	1		1	1	1	1	1			1	2			4	1				1		1	4									3				1	4			2		2				
Fox	2	11	4	2	3	4	11	3	6	9	6	5		9	8	4	4	8	7	2	6	8	2	1	3	5	6	6	4	4	11			6	3	5	2	4	3	5	2	4	4		
Fungi									2															1																					
Fresh.w.Crust									1	1										1		1					1	1																	
Fly																							2				1																		
Goat	1	1		2										1																				1			1		1						
Hen																																		2			2		1		1				
Herbivour			1	1					1					3								2				1	1			1	1									1	1				
Honey bee	2				1			1			1								2	1	1		1				1	1							1	1						1			
Horse			1	1				1						3				1	2			2	1								3					1		1			2		1		
Lamprey																																													
Leech															1												1							1		1							1		
Leopard										1	1							1								1																			
Lion		1		2			10	5	1	1	5	3		7	3					1		1	9	1	2			2			7			10					2	3	4		3		
Lizzard																			1																										
Mammal								1		1				3				1																			1								
Man	6	11	12	15	9	4	6	7	7	8	12	4		18	17	11	4	10	20	8	9	21	8	3	6	11	5	8	7	3	12			10	8	10	7	1	4	3	8	1	7		
Monkey										1					1				2																					1					
Mould																							3												1										

Table 13.22 (continued): Raw data obtained from item 10B.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Mushroom	1							2					1							2								1	1			1			1	1	1				1				
Non-green pl	2																	1	1			1																			1	1			
Ostrich												1																																	
Owl										1					1																														
Parasite					2					1													1				2		1																
Pig																																						1							
Rabbit	4	9	8	5	9	6	8	5	6	2	3	3	10		16	11	3	12	5	9	4	9	5	4	4	4	6	8	4	3		12		5	6	9	9	1	4	7	5	6	8		
Rat															2																														
Silkworm															1				1								1	1	1					1											
Sheep	4	5	4	3	3	1		2	2	3	7		7		8	5	3	1	9	4	4	15	1	1	2	7	4	6	3	2		4		2	4	3	3		3	2	5	5	2		
Shrimp												1	1						1				2			1						1							1	1	1				
Snake	1												1						2					1										1											
Sparrow				1														1																								2			
Squirrel								1																															1						
Tick									1																																				
Tiger		1								1			2										1					1											1	1	2				
Turtle			1						1																																				
Wale													1																																
Wolf			4	1						3		1	4			2	1	1	1	1	1	1		2		1		1	1					1				1		2	1				
Zooplankton			1	4	4	6	1	1			2	1	6						1		5	5												1					3						
Cock.																																					1	1							
Locust	1					1																		1															1						
Mouse						3	1	1			1		3		1	1					1	4		2		3						1		1		2			1	1	1				
Shield bug									1		1					1																													
Amphibian													1																																
Bat																1																													
Duck																1																													
Insect																								1																					
Termite																												1																	
Amoeba																														1															
pigeon																																		1											
Crab				1	1																																								

Table 22 : Raw data obtained from item 20 A.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Algae	2						1					2		1																									1						
Almond			1			1																1			1																				
Anethum														2																															
Apple		2	1				6	2			1				6	2		4	2			5		4	1			1	2			5		1	1		2	2	2		2		1		
Apricote														1								1														1									
Banana																																													
Barley			1											3																												1			
Bean							1	1		1																	1					1										1			
Beet root																																					2						3		
Carrot			1																																	1			1						
Chemosynthetic					1	1		2	2						3			1	1	3	1		5			1	2	3	1			1			1	1			4				1		
Cherry		1	1				3	3						1				1		1												3			1		1		2				1		
Cucumber			1	1																									1																
Cydonia																									1							1													
Diatoms	1							2	8	3																															2				
Fern	2						1										1	1			1	1	1						1						3		1	3			7		1		
Flowering pl.					1											2					1																		1						
Fruit tree																							2													1			2						
Geranium				4		1	1				1				4	2		2	2	3	1	4				6	2	1	1			3		2	1	1	2	2	1						
Green algae	1	2	1	4	4	3				3				5				2			6	1				1						3		2				2			3				
Green grass			2	1	1		2	2		8	1	2		1	2							1	2	1	1	1	2	1				2		2		4			1	1					
Green plant	10	12	16	13	14	12	5	9	16	9	9	6		23	21	18	6	15	12	13	10	30	22	7	8	12	11	23	13	10		19		18	9	13		8	7	9	13	12	7		
Iron Bac.	2	4	1		3	8			4					1	3	2				3	2	4		3	1	7						1		1						1		1			
Juniperus			2		1			1								1		2	2					1					1												2	1			
Lentice																																										1			
Lettuce															1										1	2										3				2					
Lichen																				1																									
Medicago				1							1											1			1	4													1						
Mint																						5			2																				
Moss																1																				1									
Mulberry																																						1							
Oak					1																											2			1								1		
Orange																			1																										
Palm																									1																				
Parsley																		1					2																				4		
Peach														2																							1			1					
Pear																		1	1			1										2						1							
Pinus			2	1	2			1										1																						1	2				
Platanus							1			2		1												1																			1		
Plum																																					2			1					
Photosynthetic															2								2		1															2			1		
Phytoplank				3	3	3	1		1	6	2	4		20	1	1			1	1	3	2	3	1		8		3		1							2		2	7					
Pomogranate			2																													1						1			1		1		

1a Table 13.22 (continued): Raw data obtained from items 20A and 21B.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Potatoe							1																													1									
Radish																			1								1	1																	
Rice																																								2					
Rose															1																					1									
Spinach									1															1																					
Spring onion														1								1																							
Sulphur. B	2	7	1	1	4	2	1	1	6		1	5		2	2			2		3	3	2		3		3						4		1		1		2			2				
Tomatoe							1																	1																					
Watermelon																			1																					1					
Wheat			1				1	1			2			6						1							1	1	1													1	2		
Willowtree							1																																						
Wine tree																			1			2		2					1			2													
Fig																																1													
Bacteria	18	21	22	20	21	20	8	14	14	15	20	1		28	24	12	3	14	18	14	8	24	18	5	9	15	16	13	8	6	10			8	8	19	15	14	14	8	11	9	19		
Bread mould	4	8	3	3	4	1	4	7	10	8	10	7		8	6	9	4	6	4	1	4	4	6	7	4	7	4	3	3	1	15			5	1	1	6	2	2	6	7	2	6		
Mould	5	5	10	2	4	3	2							8	21	7	1	7	2	12	5	25	9	1	3	8	2	4	6	5	5			2	6	13	7	10	5	4	4	7	4		
Mushroom								10		8	10	5			7					3			2							2	1					5	5		6	2		4	4		
Virus																		1	1				2		1			3						1	1							4			
Yeast							3											1						1																					

extent that curriculum objective had advocated. There were several reasons responsible for these results:

(a) In most schools chapters 7 and 8 on Varieties of Ecosystems were not taught by the teachers but left to students to learn by themselves.

(b) The activities in the textbook and field works were not popular in schools and mostly were discouraged by the administrators.

(c) The link between materials presented in the first chapters and the last two chapters was not explicit in applying students' knowledge in understanding the reasons for diversities in ecosystems as well as organisms.

13.4.2 Textbook Objectives

The biology test forms had 42 items based on 42 specific objectives. These items were measuring roughly 20 percent of the total objectives in the whole textbook. They represented a wide range of concepts and principles at various levels of achievement.

Items developed for pilot study were short-answered and open-ended questions. They were used as the stems of Multiple choice questions in the experimental versions. In this transition the items showed a gain in achievement. Few items become very difficult in new format (see Figure 13.23 and Figure 13.25).

The gain in total achievement of individual items could be interpreted in terms of item improvement, and the results from the change of the item format. In the process of test validation, individual items became more specific

Figure 13.23: Item facility of the biology achievement test items for the pilot and experimental groups. Questions 1-4 of Form A are identical to questions 23-26 of Form B.

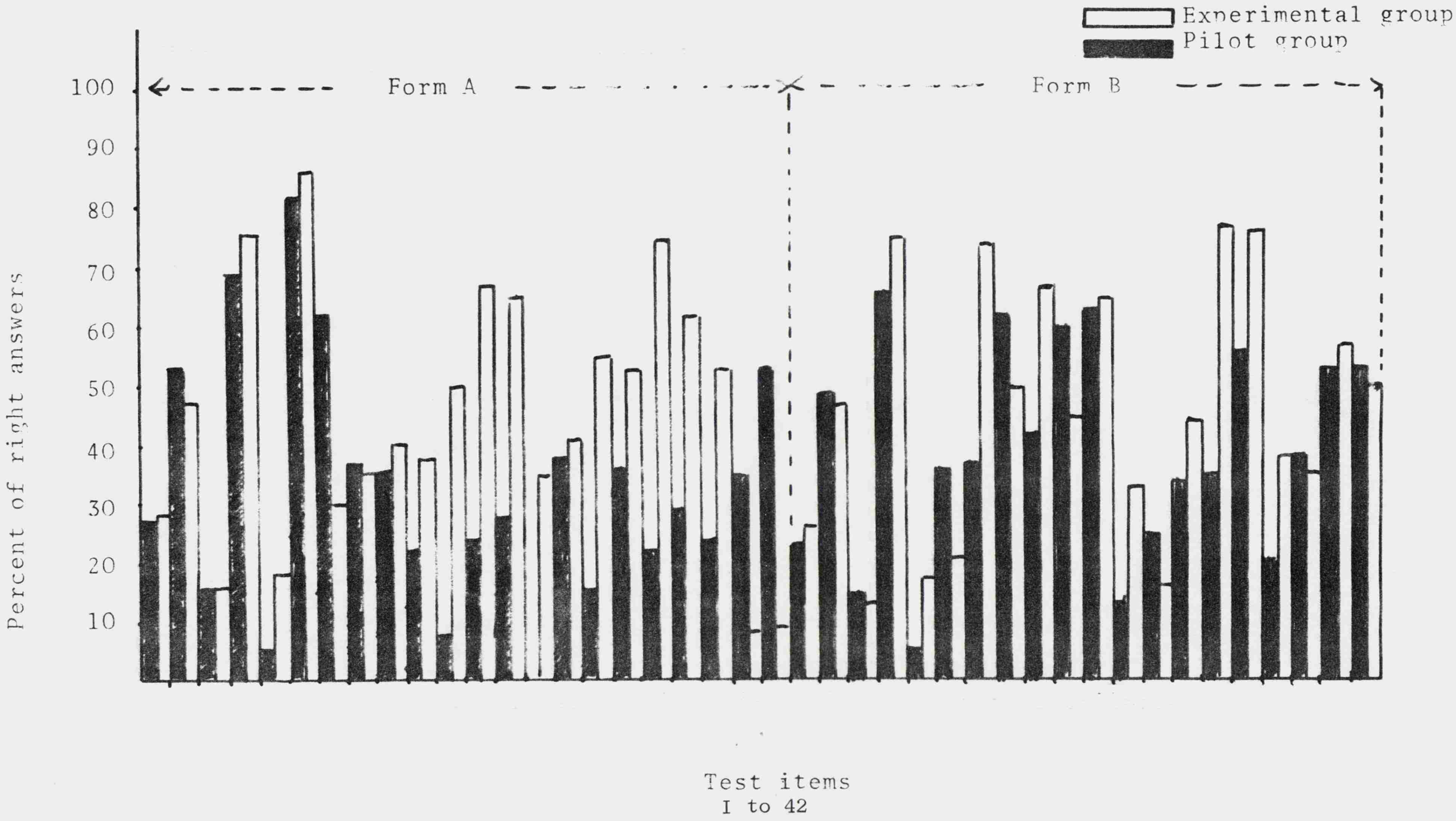


Figure 13.24: Item facility of the whole-test and experimental groups of the biology achievement test items. Questions 1-4 of Form A are identical to questions 23-26 of Form B.

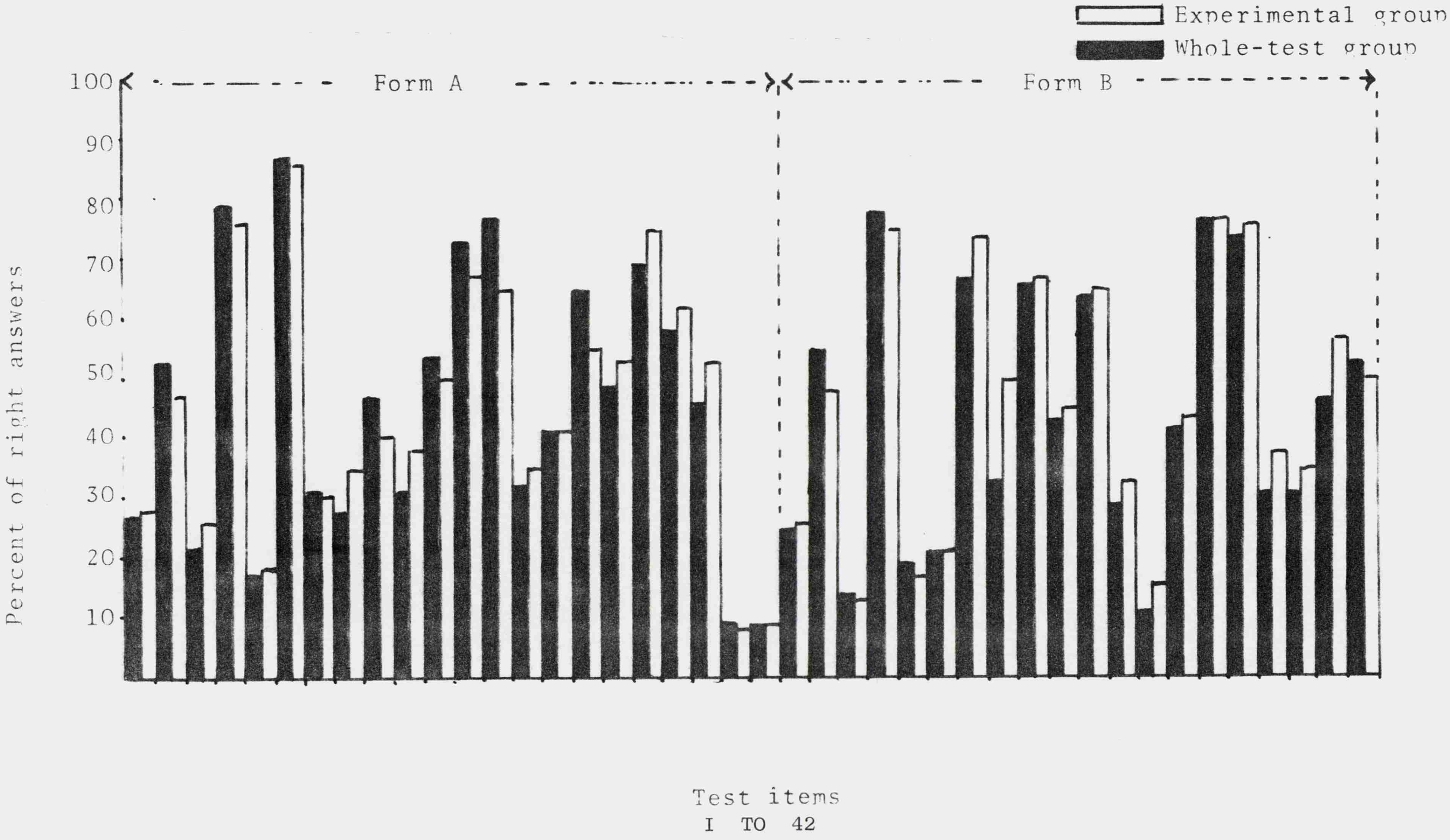
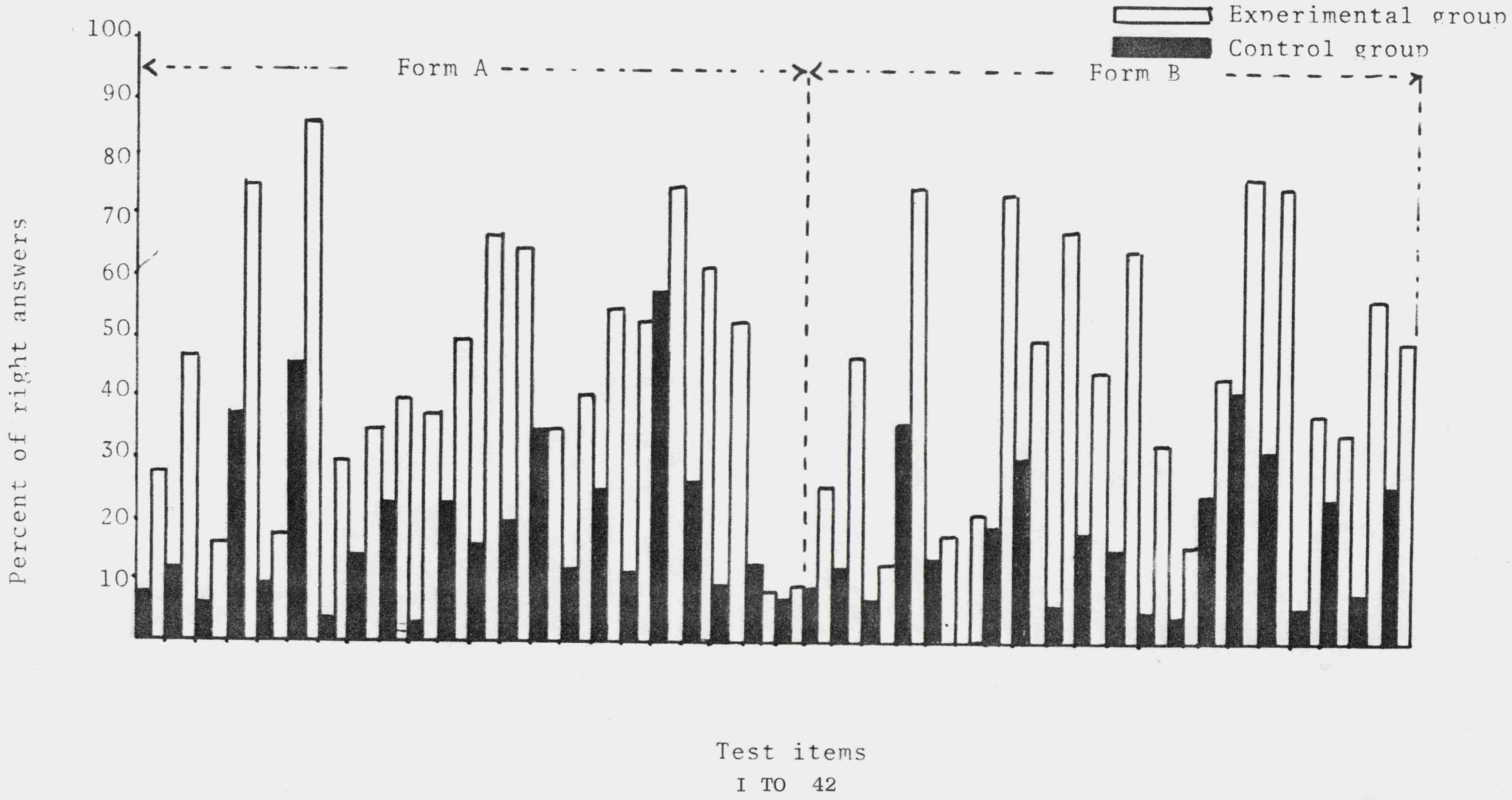


Figure 13.25: Item facility of the control and experimental groups of the biology achievement test items. Questions 1-4 of Form A are identical to questions 23-26 of Form B.



in their objectives. They measured specific segments in the test which were different in various editions. This charac--teristic, well represented by the items 22 and 23 of the Form A (or 21 and 22 on computer programme), led to different test scores in pilot and experiment study for the same items.

On the whole, both test forms consisted of items which were sensitive to instruction (Figure 13.23). These tests maintained similar test scores when they were tried by two different groups or by the same individuals (Figure 13.24). Few discrepancies in the scores, particularly, on the test items measuring the same domain should be regarded as the result of test wiseness, student practice, or cheating during the test procedures.

If we compare the results of these two test forms with those marks given by the teacher in his first and second term examination we come to some interesting conclusions, especially when we compare scores obtained by different sexes. Figures 13.26 to 13.29 shows these results:

1. The general distribution of the biology test forms had a bell shape of normally distributed scores. Most of the scores in the control group were clustered to the left and were well below the cut-off score (60 percent). The distribution of the teachers' scores were skewed to the right side of the cut-off score and on the whole were positively skewed to the right side of the mean value. These results were more or less identical on all the frequency polygons produced for the

Figure 13.26: Frequency polygons showing boys' performance in the control group and the experimental group for the biology test Form A and teachers' examinations.

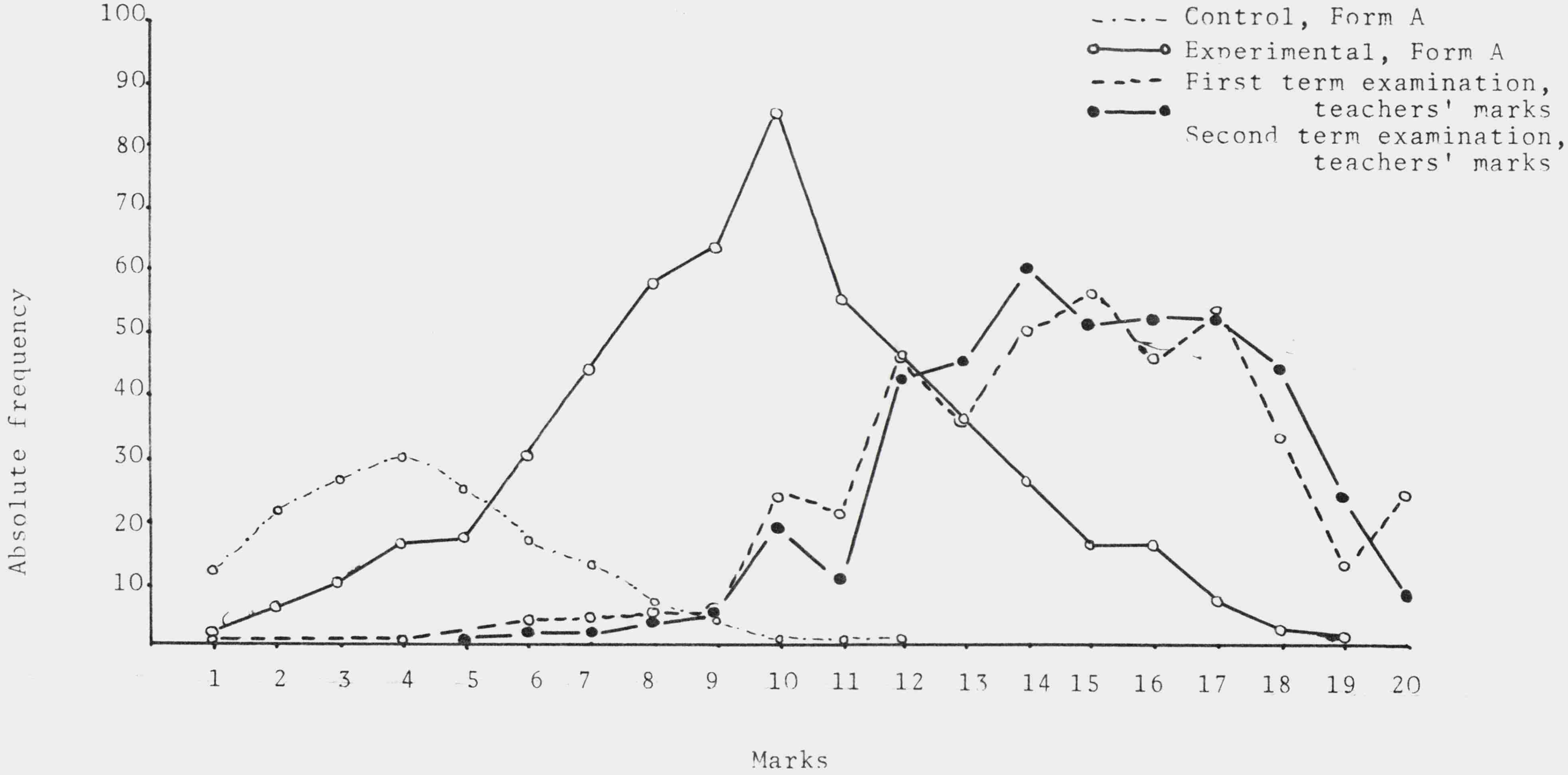


Figure 13.27: Frequency polygons showing boys' performance in the control group and the experimental group for the biology test Form B and teachers' examinations.

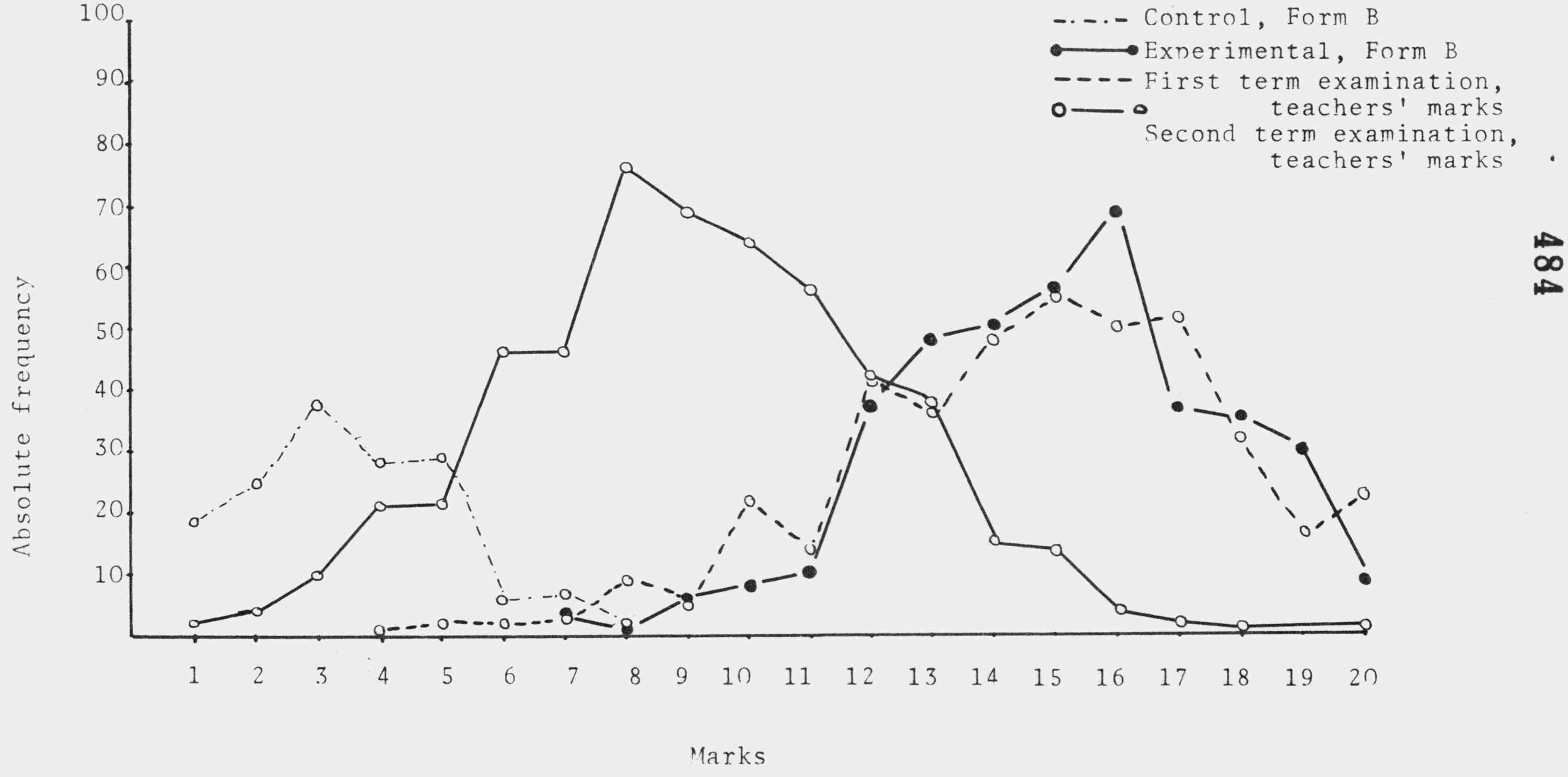


Figure 13.28: Frequency polygons showing girls' performance in the control group and the experimental group for the biology test Form A and teachers' examinations.

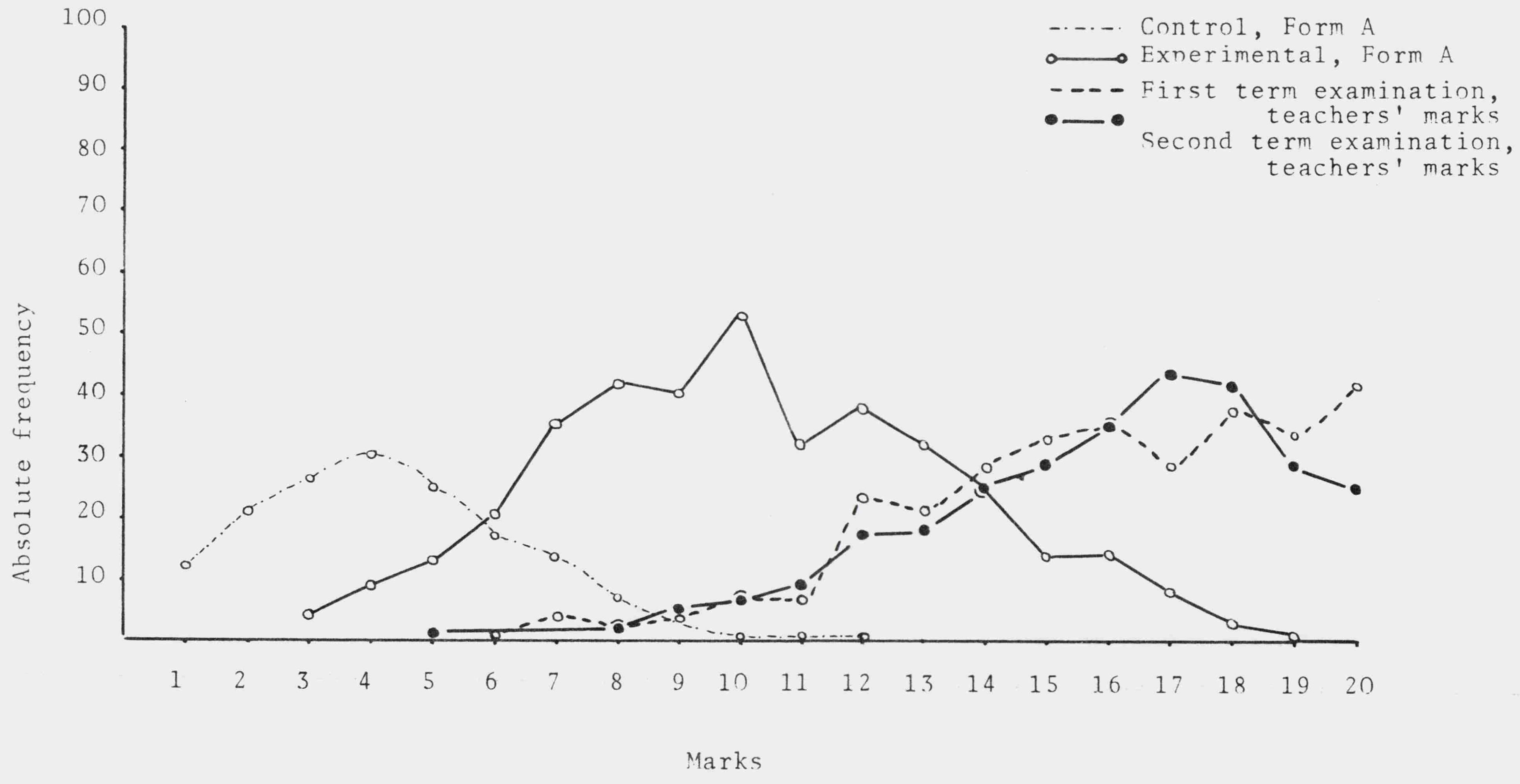
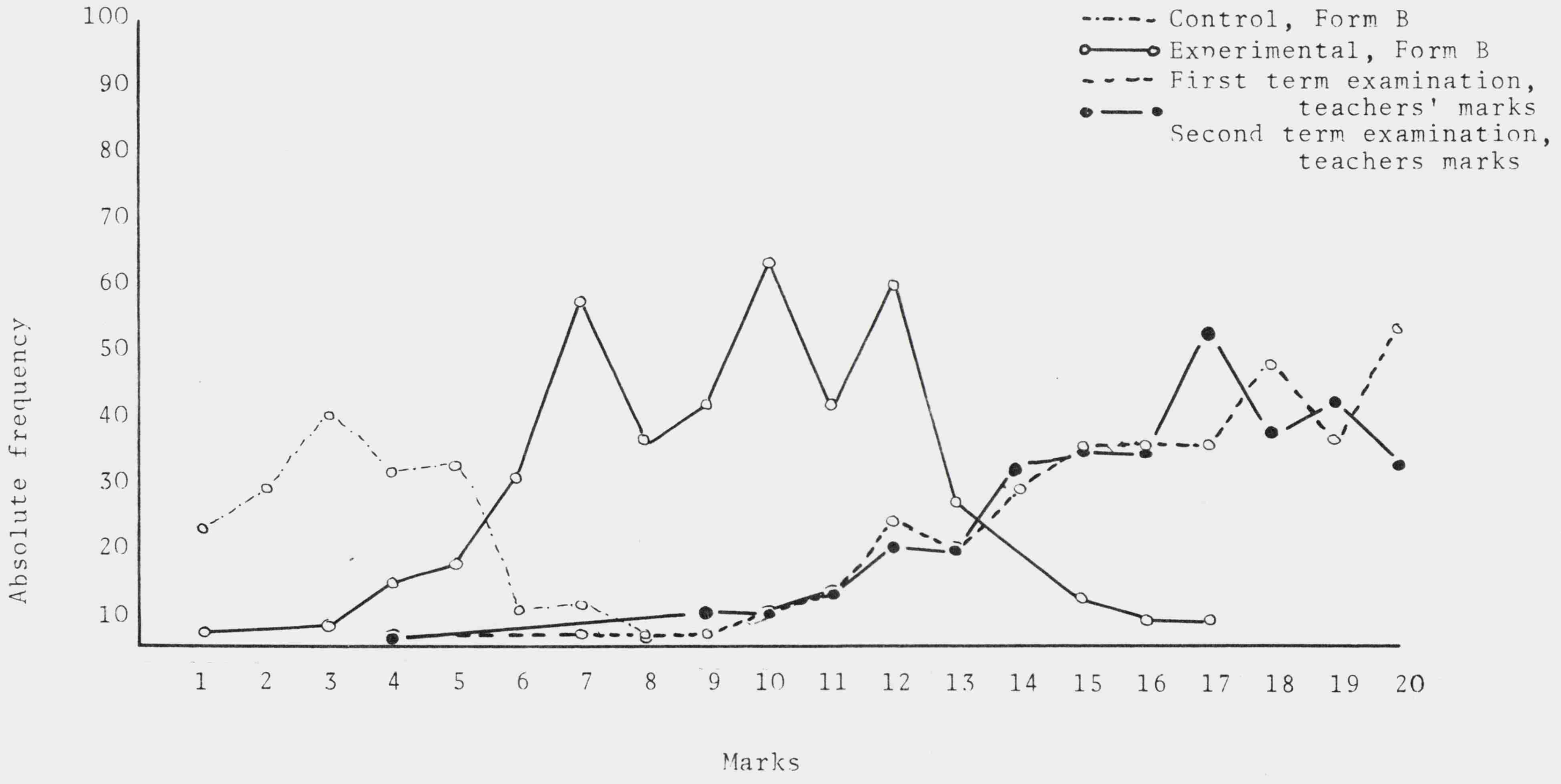


Figure 13.29: Frequency polygons showing girls' performance in the control group and the experimental group for the biology test Form B and teachers' examinations.



two forms of the biology test for the two sexes.

2. These Figures and their summaries in Table 13.30 showed that the teachers' marks for internal examination were highly distorted. The marks obtained in the second term had higher values than those from the first term. The girls achieved higher scores than the boys. The scores mean median provides good data for these comparisons.

Table 13.30: Percentage of boys and girls obtaining a total score over 12. Condescriptive statistics of the scores obtained from Form A, Form B, first term and second term examination.

Test	Sex	Percent over 12	M	S.D.	S.E.	Median
Form A	both	31.0	9.9	3.2	0.1	9.9
Form B	both	24.0	9.3	2.9	0.0	9.3
Form A	girls	35.2	10.2	3.2	0.1	10.0
1st term A	girls	91.8	15.8	3.1	0.1	16.1
2nd term A	girls	90.0	15.8	2.8	0.1	16.4
Form B	girls	26.8	9.5	2.8	0.1	9.6
1st term B	girls	93.7	16.3	3.0	0.1	16.7
2nd term B	girls	93.2	16.1	2.8	0.1	16.6
Form A	boys	16.0	9.7	3.2	0.1	9.7
1st term A	boys	84.9	14.5	3.1	0.1	14.7
2nd term A	boys	89.8	14.7	2.7	0.1	14.9
Form B	boys	14.0	9.1	3.0	0.1	9.0
1st term A	boys	85.7	14.6	3.1	0.1	14.9
2nd term A	boys	91.0	14.9	2.6	0.1	15.0

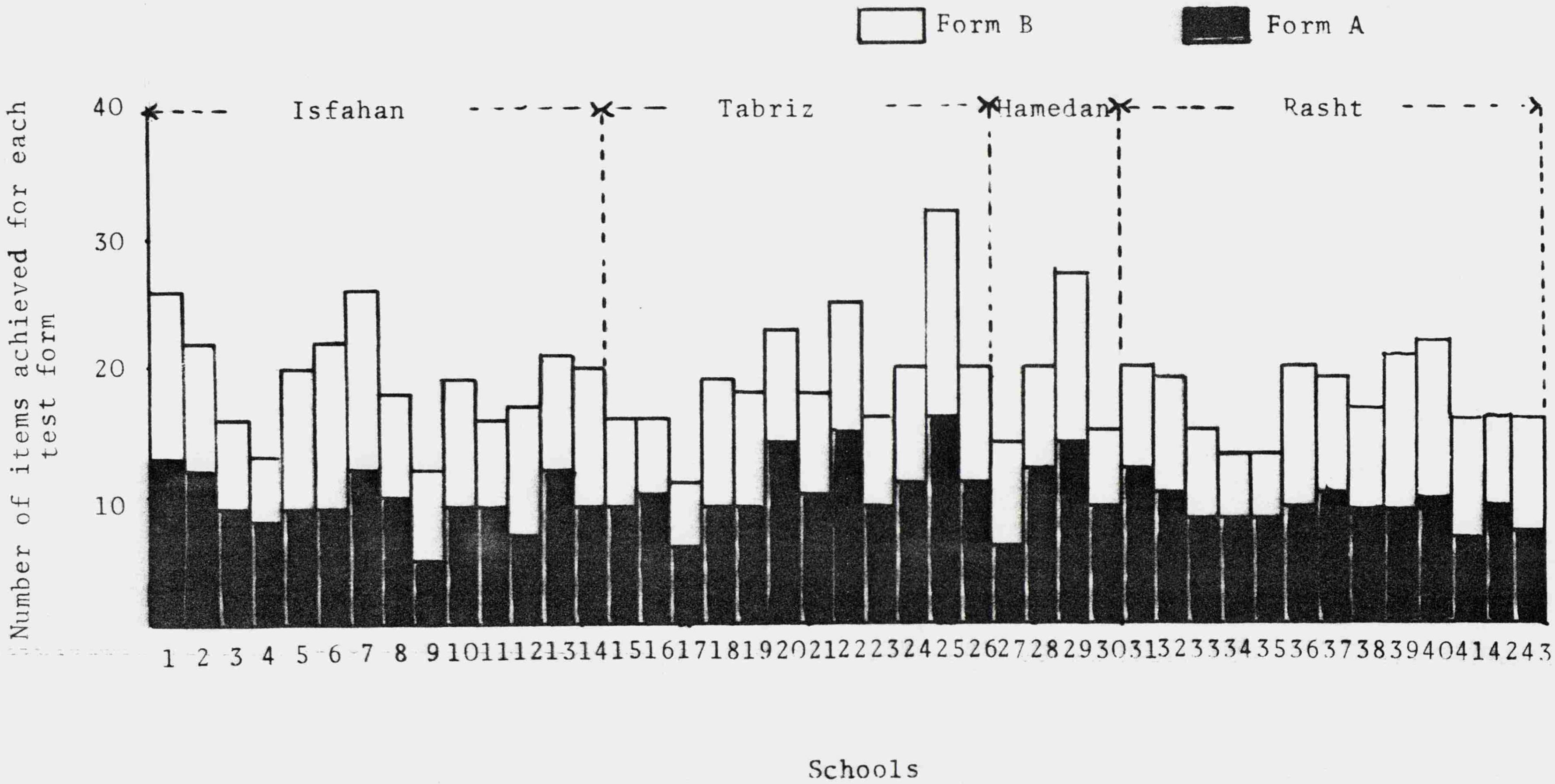
In Iran, when the teacher sets his examination paper for the second term examination, he selects his test items from the whole material taught in the first and second term. Although the pass mark is officially 12 out of 20, teachers are not teaching for mastery learning. They follow a traditional authoritarian style of teaching which emphasizes rote memorization of what the teacher could present in his instruction. It was therefore very hard to believe that mastery learning of the whole curriculum material was their objective.

In the previous pages, it was noticed that difference in instructions caused variance in test item scores. The comparison of the 43 schools in terms of total mastery of the biology test items suggested how differently the teachers used the instructional materials (Figure 13.31). These data suggested one might be dealing with a situation known as hidden curriculum. (37).

In the absence of a criterion for comparison between teachers' marks and what students could do, it was difficult to prove the existence of hidden curriculum. The biology test provided a good basis to argue that teachers and students had reached the same agreement on what should be taught and learnt. The following results provided evidence for this conclusion:

1. A high percentage of students achieved above the pass mark.
2. A different achievement of various items at 60% cut-off score occurred in different schools.

Figure 13.31: Number of test items, in the biology achievement test, answered by each school in the sampling population.



3. The comparison between the results obtained from the biology tests forms and those of the teachers' marks.

Some other evidence from observation in schools and interview with students and teachers confirms this assumption.

It is therefore concluded that different teachers achieved the textbook objective differently. On the whole, what they were practising was a simplified version of selective parts of the textbook. This could satisfy students and official expectations and facilitate teachers' achievements in the conditions in which he operates.

Table 13.32 provides further data for the experimental group.

13.4.3 The Biology Curriculum Objectives

The biology curriculum objectives were concerned with cognitive, affective and psychomotor domains.

The present discussion is mostly concerned with cognitive domain. The discussion of other domains can be found in Chapter 7 of this thesis.

The results of the goal analysis showed that although the textbook covered most of the cognitive objectives of the curriculum, their levels of achievement were different in the textbook, particularly in the materials presented in the content of each chapter. The inclusion of "Activities outside the classroom", "References" and "Questions and self-assessment" were designed to fill the gaps that may have existed between curriculum objectives and the textbook objectives when only the text was being taught.

Table 13.32: Some data obtained from experimental group, performing the biology test items.

Item		Mean	S.D.	Discrimination	Total pass	Item facility	Masters	Non-Masters	Validity	Response Distribution % A	B	C	D	E	Percent missed	Gain over control
Form A	Q1	.28	.44	.15	260	28	158 / 130	508 / 130	.25	2.9	27.5	21.6	37.4	5.7	4.9	20
	Q2	.47	.49	.16	437	49	104 / 184	384 / 253	.24	3.2	10.4	45.5	5.9	19.9	15.1	35
	Q3	.15	.36	.13	148	15	210 / 78	568 / 70	.17	15.3	3.6	17.4	9.2	31.5	23.0	10
	Q4	.76	.42	.17	706	76	30 / 258	90 / 448	.19	3.1	1.5	7.1	3.8	75.7	8.7	39
	Q5	.18	.38	.06	176	18	207 / 81	546 / 92	.14	8.7	3.0	17.3	17.6	45.1	8.2	8
	Q6	.86	.34	.20	798	86	11 / 277	117 / 521	.16	4.9	4.8	84.6	1.1	1.8	2.9	40
	Q7	.30	.45	.31	278	30	125 / 163	523 / 115	.38	25.7	9.8	30.3	26.6	2.5	5.1	26
	Q8	.35	.47	.14	330	35	143 / 146	454 / 184	.22	21.2	33.8	7.2	4.1	21.5	12.2	12
	Q9	.40	.49	.23	374	40	110 / 178	442 / 196	.31	7.9	12.4	18.5	38.8	5.2	17.3	37
	Q10	.38	.48	.26	356	38	104 / 184	466 / 172	.37	18.1	36.0	12.7	4.0	9.6	19.5	15
	Q11	.50	.50	.23	469	50	91 / 197	366 / 272	.27	19.9	5.4	5.0	9.0	48.7	11.9	27
	Q12	.67	.47	.33	621	67	24 / 264	281 / 357	.36	16.2	63.6	3.5	2.3	6.0	8.4	51
	Q13	.65	.47	.33	608	65	28 / 260	290 / 348	.36	63.7	18.5	2.4	3.7	3.1	8.6	45
	Q14	.35	.47	.11	327	35	150 / 138	449 / 189	.18	6.3	30.3	34.0	5.1	9.6	14.7	00
	Q15	.41	.49	.22	381	41	112 / 176	443 / 205	.28	4.6	8.1	41.8	31.5	5.6	8.3	28
	Q16	.55	.49	.27	514	55	59 / 229	353 / 285	.35	7.2	54.1	7.6	8.2	6.5	16.4	30

Table 13.32 (continued)

Item		Mean	S.D.	Discrimination	Total pass	Item facility	Masters	Non-Masters	Validity	Response Distribution % A	B	C	D	E	Percent missed	Gain over control
Form A	Q17	.53	.49	.25	496	53	64/224	366/272	.35	50.5	14.5	5.8	2.1	11.2	15.9	42
	Q18	.75	.43	.15	695	75	35/253	196/442	.19	4.9	72.7	1.7	4.5	4.4	11.8	18
	Q19	.62	.48	.24	577	62	45/243	304/334	.32	10.5	5.3	3.1	61.4	6.6	13.1	20
	Q20	.53	.49	.24	496	53	71/217	359/279	.32	10.9	2.6	6.8	52.7	15.4	11.6	40
	Q21	.08	.28	.02	80	8	248/40	598/40	.07	8.1	6.6	26.8	12.6	30.7	15.2	-5
	Q22	.09	.29	.02	86	9	253/35	587/51	.05	19.8	38.4	8.2	5.2	5.9	22.5	2
Form B	Q23	.26	.44	.10	243	26	123/100	560/143	.24	4.0	25.9	21.5	35.7	7.6	5.3	17
	Q24	.47	.49	.20	439	47	62/161	425/278	.47	3.5	9.2	45.7	5.8	20.8	15.0	35
	Q25	.13	.33	.18	123	13	154/69	649/54	.23	13.0	3.2	18.4	10.4	31.7	23.3	6
	Q26	.75	.43	.13	699	75	29/194	198/505	.16	3.7	2.8	7.6	3.6	75.6	6.8	39
	Q27	.17	.37	-.007	160	17	174/50	593/110	.11	7.1	3.7	17.2	18.1	43.3	10.6	3
	Q28	.21	.41	.20	201	21	121/102	604/99	.31	12.5	20.0	62.7	1.7	.8	2.3	21
	Q29	.74	.43	.13	688	74	28/195	212/491	.20	1.1	3.6	17.3	71.9	2.6	3.6	55
	Q30	.50	.50	.11	466	50	74/149	384/319	.21	18.0	47.7	21.6	6.4	1.7	4.5	20
	Q31	.67	.46	.29	626	67	18/205	282/421	.32	2.6	1.9	9.7	68.3	7.9	9.6	61
	Q32	.45	.49	.20	419	45	76/147	431/272	.27	9.3	2.1	44.5	8.3	28.6	7.2	67

Table 13.32 (continued)

Item		Mean	S.D.	Discrimination	Total pass	Item facility	Masters	Non-Masters	Validity	Response Distribution % A	B	C	D	E	Percent missed	Gain over control
Form B	Q33	.65	.47	.33	603	65	15 / 208	308 / 395	.37	5.2	10.6	4.8	64.5	8.5	6.5	50
	Q34	.33	.47	.21	307	33	100 / 123	519 / 184	.29	33.5	19.2	27.6	10.3	3.9	5.5	28
	Q35	.16	.37	.16	152	16	148 / 75	626 / 77	.23	5.0	10.2	16.6	28.0	24.4	15.8	12
	Q36	.43	.49	.20	407	43	77 / 146	442 / 261	.28	77.7	15.0	8.6	6.0	41.4	21.8	20
	Q37	.77	.41	.04	720	77	37 / 186	169 / 534	.08	2.9	2.4	2.5	75.3	13.5	3.5	35
	Q38	.76	.42	.25	705	76	9 / 214	212 / 491	.26	2.9	4.8	12.0	1.4	75.1	3.9	44
	Q39	.38	.48	.20	357	38	78 / 145	491 / 212	.35	38.7	17.1	15.1	4.0	6.2	19.0	32
	Q40	.35	.47	.10	332	35	103 / 120	491 / 212	.23	38.4	35.2	9.3	2.1	5.9	9.1	11
	Q41	.57	.49	.30	531	57	28 / 195	367 / 336	.37	3.5	7.0	9.9	57.8	4.5	17.3	49
	Q42	.50	.50	.13	471	50	69 / 154	386 / 317	.24	30.7	6.9	48.9	1.5	1.3	10.7	24

In the present discussion, many evidences suggested that even when the textbook was the only means of instruction, not many teachers equally treated its details.

13.5 Summary

The biology achievement tests were developed on the basis of the results obtained from curriculum and goal analysis. These tests were revised in the pilot study and the final versions were used in the experimental study.

The test items tried and revised in the pilot study were used as the stems for developing multiple choice items. The responses collected from each item were used for developing distractors for its multiple choice version. However, three questions, i.e. Nos. 10B, 21B and 20A, were kept as original open-ended and short-answered questions to fulfil special achievements required from students. The results obtained from the test were valuable

1. The validity of the test was described as content and descriptive validity, test sensitivity, item-objective congruency, stability and interval consistency. The two versions of the test were correlated and had an average internal consistency, showing that all objectives were derived from the same subject (ecology). The consistency of parallel items and retest items also provided additional data for the homogeneity of the test.
2. The question of applying reliability indices developed for the CRT was rejected since the test consisted of different objectives and had been tried on heterogenous population of students.

The low variance of the test, however, provide variabilities for comparison between scores and item analysis to revise the test items.

3. The test was sensitive to instruction and had no specific bias for sexes nor geographical areas, suggesting that although there were many differences in these areas the students' achievements were similar since the instructional materials they used were the same.

4. The differences between total scores obtained from schools and the divergent use of textbook examples suggested that although in general there were no differences between sexes or achievement of students in different areas, in terms of individual items not all the teachers were achieving the same set of objectives. It followed that one might be investigating a hidden curriculum.

   The comparison between teachers' marks for examination and those obtained from the test form provided more evidence for the existence of the hidden curriculum.

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3. Some authors have used domain as a universe of content from which a number of items could be generated for measuring the attainment of the domain objective. Domain as a specific objective underlines the same function.

4. This comment refers to the work of BORMUTH, R.J. (1970) in his book *On the theory of achievement test item* published in Chicago by the University of Chicago Press. Bormuth had applied a linguistic transformational approach to generate items from segments or sentences in the students' textbook.

   HIVELY, W.W. (1974), in his book on *Domain-referenced testing,* published in New Jersey by Educational Technology Publications, defines a domain as an 'Item-form'. By item-form he conceptualized certain rules that lead to the generation of a set of related items for measuring a specific objective. The term of 'universe of content' or item universe was used by OSBURN, H.G. (1968), in his article on "Item sampling for achievement testing" in *Educational and Psychological Technology,*

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APPENDIX 14

TEACHERS' QUESTIONNAIRE - TECHNICAL REPORT

In the Iranian system of education little research has been reported on teacher education. The official reports are mostly concerned with the quantitative expansion of the educational system. The few research dissertations in higher educational institutes lack the precision required from a research design, because no detailed technology is yet available for research at these institutes. Most of the higher educational institutes are new and are short of staff. The language barrier prevents students from making use of foreign references.

In this situation, attention has been directed towards the evaluation of students' achievements. It has been assumed that higher education was successful in preparing the biology teacher. A certificate in a specialized subject automatically qualifies a man to become a competent teacher in secondary schools.

The development of the teachers' questionnaire was an attempt to answer some questions about these problems. In addition, the questionnaire looked at the effects of the implementation of the new biology curriculum.

14.1 The Development of the Teachers' Questionnaire

During the intrinsic evaluation of the biology curriculum materials, certain questions arose about the role of the biology teachers:

1. What academic background has the biology teacher who teaches the new biology curriculum?

2. What objectives does he pursue in his training and learning environment?
3. What methods does he use for his teaching, timetabling and assessment?
4. What effect has the conflict between the old and new curriculum on his attitudes and performance?

The questions about the role of the biology teachers advocated guidelines for developing the interview format and teachers' questionnaire.

During the pilot study the use of a taperecorder proved to be impossible. Teachers showed hostility to any sort of recording devices. Even note-making about teachers' responses was distracting. The teachers wished to review their recorded responses to ensure that their unedited responses were not opposing the official view.

It was, therefore, decided to develop a relaxed interview in which answers were written by the interviewee immediately after the termination of the interview, and in the absence of the teacher. Sometimes, it was possible to check the teachers' responses on several occasions to confirm its consistency.

The establishment of rapport (1) provided comprehensive information about various aspects of the system of education and the new biology curriculum. It pinpointed the problem areas and confirmed the four areas of inquiry suggested at the beginning of this section.

The results also led to the revision of the above questions and specification of their details. The following questions are the English translations of these details.

1. <u>General information</u>:

1.1 How many years have you been teaching?

1.2 How many years have you taught in this city?

1.3 What was your original subject specialization?

1.4 What subject(s) do you teach?

1.5 How many hours per week do you teach at different levels of the educational system?

1.6 What qualifications and certificates do you have?

1.7 How many years have you taught at each different level of the educational system?

1.8 What sort of administrative job have you had in addition to the teaching?

2. <u>New system of education and the new biology curriculum</u>:

2.1 How/when did you know about the new biology curriculum?

2.2 When did you see the textbook; what was your first attitude towards it?

2.3 What attitudes to the textbook can you recall from your colleagues?

2.4 Has your attitude been altered since you started to teach this curriculum?

2.5 What is your present attitude towards this curriculum?

2.6 What is your attitude towards this curriculum compared with the old one?

2.7 Which of the curriculum goals have featured in the textbook?

3. Teaching and learning the new biology curriculum:

3.1 What was the students' attitude towards this curriculum when you first introduced it?

3.2 What are the main difficulties in teaching this curriculum?

3.3 What methods do you use to teach it?

3.4 How do you use the experiments?

3.5 How do you use the questions at the end of each chapter?

3.6 How do you use the chapter references?

3.7 How do you use the activities outside the classroom?

3.8 Which experiment is best done in your own situation?

3.9 Which experiment do you find effective in helping students grasp the meaning of a difficult concept?

3.10 Are your students interested in ecology?

3.11 Do you like teaching ecology?

3.12 Have your students any difficulties in reading the text?

3.13 Do they read but not understand it?

3.14 How do you test your students?

3.15 What type of examination test items do you usually use?

3.16 Could you write down three typical items you have used for examination purposes?

3.17 Did you, yourself, read any of the chapter references?

4. <u>In-service training and the management problems</u>:

4.1 When you first started to teach this curriculum, was your headmaster aware of the chemicals, and equipment and other laboratory facilities required?

4.2 Have you ever discussed with him what you needed?

4.3 What was his reaction?

4.4 Was he co-operative?

4.5 Do you have a laboratory?

4.6 Do you have enough materials and equipment to enable you to do the experiments?

4.7 Are your classes so crowded with students that you can hardly move?

4.8 How many months do you spend teaching the ecology section?

4.9 How much time per week do you spend on preparation of your teaching plan?

4.10 If you had a choice between different grades and school levels, to which level would you like to allocate all your weekly programme (time-table)?

When the above list of questions was prepared, they were scrutinized for relevance to the topics. The questions were translated into English and a panel of Ph.D. tutors checked them and made critical suggestions.

At this stage it was again necessary to go through the details of the reports made in the pilot study to check the details of each question and examine its relevance to the objective. These questions were then converted into questionnaire items.

There are several standard textbooks about how to develop a questionnaire. (2)(3). But all assume that the the respondents have already been acquainted with the questionnaire format and know how to answer. A person who has gone through the educational system, becoming a teacher, has filled in many types of questionnaires.

The above conditions do not exist in Iran. The written statement had always been used as solid evidence. In the educational system most of the bureaucratic jobs were carried out orally and officially registered by the bureaucrats.

However, in recent years teachers have been introduced to a type of questionnaire. This questionnaire was distributed by officials to obtain reactions and attitudes towards in-service courses. Also when teachers wanted to apply for travelling abroad, they had to fill in a factual questionnaire. The format of both questionnaires was very simple.

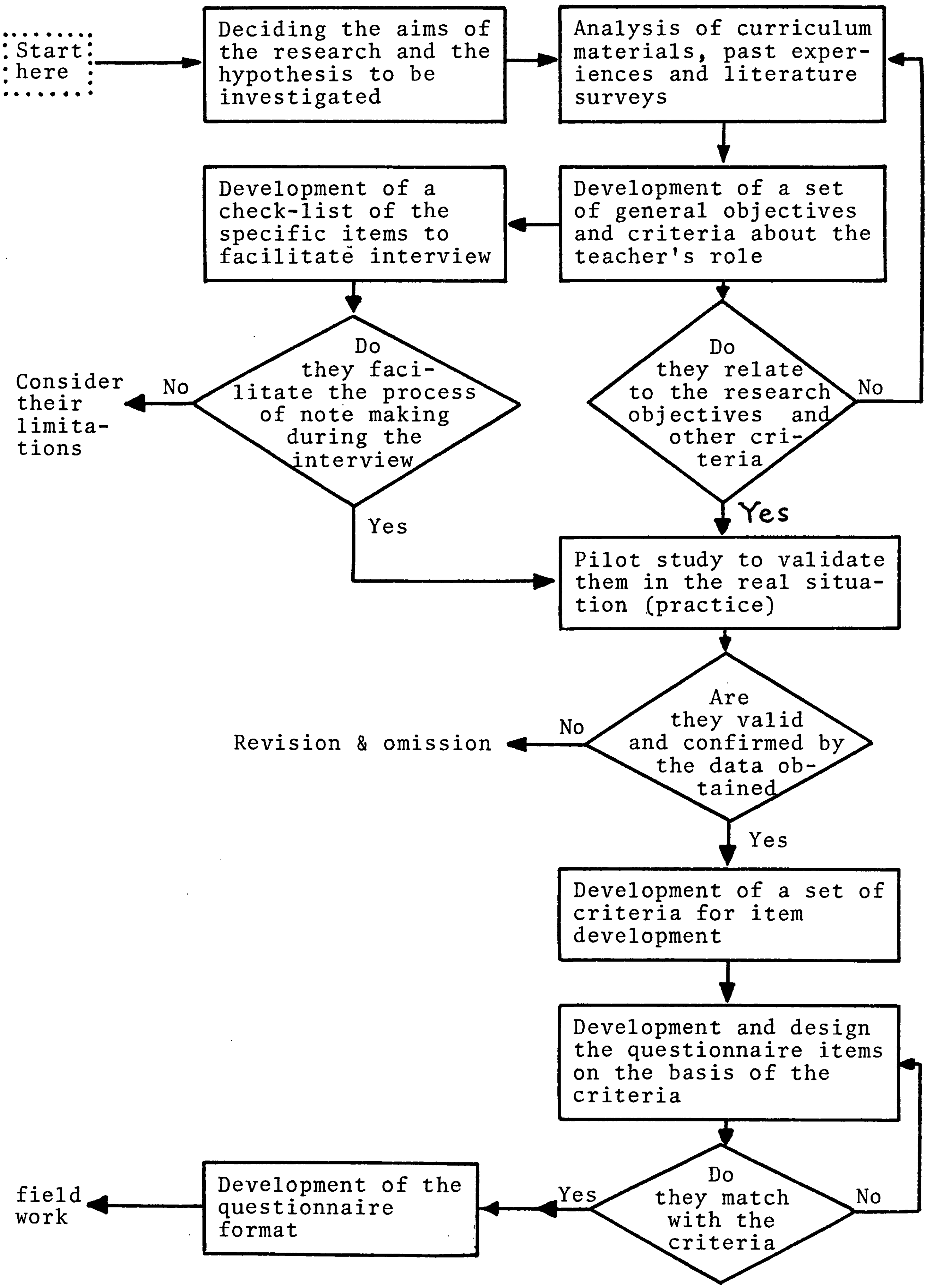
Similarly, the format of the questionnaire used in this study was kept as simple as possible. Detailed and clearly defined instructions were provided.

The Figure 14.1 is the algorithm of all the decision making in the development of the teachers' questionnaire. The final version of the teachers' questionnaire can be found in Appendix 7. This version had been checked for item-objective congruence. (4). The items were also checked by the Ph.D. panel.

14.2 Sampling Design for the Teachers' Questionnaire

The teachers' questionnaire was designed to be used at the beginning of the 1976-77 academic year. Copies of the questionnaire and stamped envelopes were sent out to 266 teachers. These teachers were randomly selected (by the use

Figure 14.1: The algorithm of the procedure of the decision making in the development of the teachers' questionnaire.



of the table of random numbers) from the list of those who attended special in-service courses which were run by the Department of In-service Training.

The questionnaire was accompanied by an instruction sheet and a covering letter (see Appendix 7). After an interval of 20 days, 50 copies of a letter (see Appendix 7) were sent to a group of non-respondents chosen by the use of the table of random numbers. Again, 50 copies of the questionnaire (see Table 14.2) were sent by the use of the same procedure on the remaining non-respondents. After two months, the above procedure was repeated by sending a different letter (called letter No.2 in Table 14.2) to the non-respondents and asking them to reply as soon as they could.

After five months (March 1977), 151 questionnaires had been returned. Eight teachers wrote back that they had never received any questionnaires. Ten had been transferred to other places and 5 found the content of the questionnaire irrelevant to their present teaching (these teachers were, at the time of this research, either teaching other subjects or had a position in the Department of Education). Table 14.2 summarizes the above details.

The number of non-respondents is calculated by the following formula (5):

$$R = 1 - (n-r)/n$$

where R = respondent, r = respondent from the total population

n = total number of the teachers.

Table 14.2: How teachers responded to the postal questionnaires

No. of teachers	First responses	Responses after the first letter	Responses after sending second copy of the questionnaire	Responses after sending letter no.2	Late return[1]	Total
266	66	14	26	13	32	151

1 - 32 questionnaires were received after March 1977, 5 months after dispatching the questionnaires and 2 months after the dead-line, after the Iranian new year holiday.

In the above case:

$R = 1 - (266-151)/266$

$R = 0.58.$

The non-respondents were 0.42% of the original sample.

14.3 Structure of the Teachers' Questionnaire and Methods of Analysis

The teachers' questionnaire consisted of 41 items. The factual information, i.e. sex, marital status, were asked in short and structured questions. The checklists were used for items which contained several categories.

Attitudes were assessed by using a Likert-type scale (question nos. 29, 30). In some cases (question nos. 13, 40) an open-ended question was used to measure attitude. Responses were interpreted into very bad, bad, neutral, good and very good categories and the results were analysed in the same way used for Likert-type scales.

The rest of the questions were short-answered questions which required one or two sentences in response (i.e. question no. 25).

In the Table 14.3 the code name for each question on the teachers' questionnaire and the statistic (6) used for their analysis of their scores are represented. Table 14.4 describes what each code name is represented for (see also Appendix 16.2.B on microfische).

14.4 The Analysis of the Teachers' Questionnaire

In the process of registering the data obtained from teachers' responses to the questionnaire items, four questionnaires were discarded. These questionnaires were answered

Table 14.3: Variables in the teachers' questionnaire and statistics used to analyse data obtained from them. (See Table 14.4 for the meaning of each computer code name used here.

Scale	Variable	Statistics Used
Nominal	SUBJ 1 TO SUBJ 5 (I), OTHPOF, MDG, CERT 1 TO CERT 8 (I), DESIRE (D), INBOOK 1-8, DIFFIC, REDIF (D), METHOD, EXPERI, CONCEPT (I), HISMETH (D), WICHOIF (D), AWARE, SUPP, COOP, INTER (I).	Mode, Frequency, Mean, Standard deviation, Standard error, Median. (Chi-square)[1]
Ordinal and Interval	HOLV 1 TO HOLV 10 (I), LEVYR 1 TO 10 (I), ATTITUD 1-4 (D), AIMP 1-8, AIMD 1-8 (D), AIMTOT 1,2 (I), WEEKS, HOURS (I) TEACHER STUDENT (E), NEED 1 TO 7 (D).	All the above, and K-S Test[1], Spearman Correlation, Kendall rank Correlation, Split-half reliability. Pearson Correlation

(D) = Dependent variable, (I) = Independent variable.

1 = Test of significance.

Table 14.3: Variables in the teachers' questionnaire and statistics used to analyse data obtained from them. (See Table 14.4 for the meaning of each computer code name used here.

Scale	Variable	Statistics Used
Nominal	SUBJ 1 TO SUBJ 5 (I), OTHPOF, MDG, CERT 1 TO CERT 8 (I), DESIRE (D), INBOOK 1-8, DIFFIC, REDIF (D), METHOD, EXPERI, CONCEPT (I), HISMETH (D), WICHOIF (D), AWARE, SUPP, COOP, INTER (I).	Mode, Frequency, Mean, Standard deviation, Standard error, Median. (Chi-square)[1]
Ordinal and Interval	HOLV 1 TO HOLV 10 (I), LEVYR 1 TO 10 (I), ATTITUD 1-4 (D), AIMP 1-8, AIMD 1-8 (D), AIMTOT 1,2 (I), WEEKS, HOURS (I) TEACHER STUDENT (E), NEED 1 TO 7 (D).	All the above, and K-S Test[1], Spearman Correlation, Kendall rank Correlation, Split-half reliability. Pearson Correlation

(D) = Dependent variable, (I) = Independent variable.

1 = Test of significance.

Table 14.4: The computer code names used for questions on the teachers' questionnaire and their meanings.

Code Name	Meaning
YOFT	Years of teaching
YOTT	Years of teaching in this town
SPEC	Specialization
SUBJ	Subject to teach
MARIT	Marital status
SEX	Sex
HOLV	Number of hours taught at each level
CERT	Certificate(s)
LEVYR	Number of years taught at each level
MDG	The most desirable grade to teach
DESIR	The desirable profession
ATTITUD 1	Teachers' attitude to the biology curriculum
ATTITUD 2	His colleagues' attitude to the biology curriculum
ATTITUD 3	Teachers' attitude to the textbook
ATTITUD 4	His colleagues' attitude to the textbook
AIMD 1 to AIMD 8	Desirability of the curriculum goals No.1 to No.8
AIMP 1 to AIMP 8	Practicality of the curriculum goals No.1 to No.8
OTHERS	Other goals
INBOOK	Goals attributed in the textbook
OPINION	Present attitude towards biology curriculum
DIFFIC	Difficulties in teaching the biology curriculum
REDIF	Difficulties that still remain
WEEKS	Number of weeks needed to teach ecology
HOURS	Number of hours to teach in a week
METHOD	Method of teaching
HISMETH	Treatment of various activities in the textbook in his method of teaching
EXPERI	Experiment best done

Table 14.4 (continued)

Code Name	Meaning
CONCEPT	Experiment best teach a concept
WICHDIF	Student's difficulties
STUDENT	Student's interest in ecology
TEACHER	Teacher's interest in ecology
INSERV	No. of in-service courses being attended
SPECIAL	No. of special in-service courses attended
NEED	Various qualities that an in-service course needs
AWARE	Headmaster's awareness of new needs
SUPP	Headmaster's activities to supply materials and equipment
BOOKS	No. of reference books read
COOP	Future cooperation
INTER	Interested in being interviewed

by teachers who had not taught the new biology syllabus and had never been to any special in-service courses. Many of the questions were either being answered in relation to their experience in the old system of education or were left blank. Therefore, the final number of questionnaires in the sample was reduced to 147.

14.4.1 General Information about the Biology Teachers

Most of the biology teachers in the sample were married men. Only 1/5 of the total sample were women teachers:

Sex	Total	Single	Married
Male	84.1%	12.4%	68.3%
Female	19.9%	3.4%	15.9%
Total:	100.0%	15.8%	84.2%

These teachers had various kinds of qualifications (see Table 14.5). Most of them were graduates of the National Teachers' Training College (N.T.T.C.) or a Faculty of Education. Few were pure scientists who had studied at a Faculty of Science. This disproportionate distribution of teacher's certification was the result of the historical development of the teachers' training and higher education institutes in the country.

The N.T.T.C. is the oldest institute for training secondary school teachers in Iran. This institute was established in 1914 and in 1934 became an integral part of the University of Tehran. For many years N.T.T.C. was the only institute for training science teachers. Prospective teachers came from two kinds of secondary schools:

(a) Students of the normal schools who were seeking a higher educational institute for their professional education. And -

(b) Students of the secondary schools who were interested in the teaching profession as their future career.

Upon their admission to the N.T.T.C. both groups of students had to sign a five year contract with the Ministry of Education to work anywhere that they would be needed after their graduation.

In later years the N.T.T.C. became independent from the University of Tehran and finally was upgraded to the University of Teachers' Training (1976). During this period, the compulsory contract with the Ministry of Education was abolished. The present University of Teachers' Training has

Table 14.5: Number of teachers who indicated that they had one or more of the following certificates.

N = 147

Certificate	Number of teachers (1)	Percent
Secondary school diploma	136	92
Normal school diploma	22	14.9
Guidance T.T. diploma	3	2.0
B.Sc. from N.T.T.C.	67	45.5
B.Ed. from a Faculty of Education	66	44.8
B.Sc. from a Faculty of Science	13	8.8
One year post graduate course	2	1.3
Others	4	2.72

(1) Many teachers had multiple qualifications. Therefore the total number of the teachers in the columns do not correspond with the number of teachers in the sample.

Table 14.6: Teachers' specializations.

N = 147

Subject	Number of teachers	Percent
Agriculture	1	.7
Biology	55	37.4
Geology	43	29.3
Natural Sciences	47	32.0
Others	1	.7
Total	147	100.0

several branches scattered in state capital cities.

The establishment of the Faculty of Education was accompanied by the expansion of higher education institutes and the establishment of new universities. Perhaps the main reason necessitating the establishment of the Faculties of Education was the separation of the N.T.T.C. from universities.

In the Faculties of Education students could follow a sandwich course of educational and science subjects. These courses were aimed to direct some of the students towards the teaching profession. In these courses students could choose some of their units from other faculties and in subjects other than education. Most of the biology teachers with a B.Ed. degree from a Faculty of Education are the graduates of these sandwich courses.

Two group factors in the society, however, dissuaded graduates of science faculties from enrolling in teaching jobs:

(1) The low status of the teacher in the society, and the low salary plus the compulsory contract with the Ministry of Education (see also Chapter Six, pp.169-172).

(2) The better opportunities in the society to find a job in their specialist interest giving higher salary.

The few scientists at the Ministry of Education are those few individuals who chose the teaching job because of their own interests.

Data on Table 14.5 shows the number of teachers who indicated that they had a specific certificate. Since many of these teachers had more than one certificate the total number of teachers on the Table does not correspond with the total number on the sample.

14.4.2

Teachers in the sample had various specializations and were teaching a variety of subjects. Details shown in Tables 14.6 and 14.7 suggest that most of the teachers had specialized in biology or geology. Those graduates of the N.T.T.C. before 1960 indicated "Natural Sciences" as their subject specialization. In those days study for a joint degree in two related subjects, i.e. chemistry/biology, physics/mathematics, was a common practice. In later years each of these subjects obtained independent status in the N.T.T.C. curriculum.

Table 14.7 shows that the above teachers were not only teaching subjects related to their specializations but also those subjects that bore no relation to the area of their degrees. The variation of subjects, in this table, is partly due to the existence of the old system of education alongside of the new one. And, partly because teachers were involved in teaching in varieties of institutes to earn enough income (see discussion in the following pages).

Tables 14.8 and 14.9 show that most of the biology teachers' time-table is spent teaching at the higher grades in both old and new systems of education. The enquiry about teachers' most desirable grade to teach further justified the above results (Table 14.10).

Table 14.7: Subjects taught by the biology teachers.

N = 147

Subject	Number of teachers teaching any of the following syllabus	Percent
Agriculture	1	0.6
Animal physiology	21	14.2
Biology	78	53.0
Biology for G.T.T.C.	1	0.6
Botany	24	16.3
Commerce	1	0.6
English	3	
Geography	1	0.6
Geology	1	0.6
Guidance Cycle		
Combined science	2	1.3
Mathematics	1	0.6
Microbiology	1	0.6
Nutrition	1	0.6
Natural sciences	67	45.5(1)
Physics	1	0.6

(1) The term Natural science is sometimes used for all the biological subjects and geology.

(2) Teachers in this sample were teaching more than one syllabus, the total number of teachers in the above table does not correspond with the total number of teachers in the sample.

Table 14.8: Number of hours biology teachers spend teaching at each level of educational system

N = 147

Level of teaching N	Number of hours	Percent
Guidance Cycle	10	6
First year of Secondary	94	63
2nd & 3rd Year	104	70
4th & 5th Year	26	17
Sixth Year	106	72
Normal School	16	10
Guidance T.T.C.	20	13
Evening Classes	48	32
Higher Educ. Inst.	3	2
Others	9	6

Table 14.9: Number of years the population of the biology teachers have taught at each level

N = 147

Level of teaching	Number of years	Percent
First Cycle	78	53
Guidance Cycle	18	12
First year of Secondary	113	78
2nd & 3rd Year	95	64
4th & 5th Year	117	79
Sixth Year	110	74
Normal School	27	18
Guidance T.T.C.	12	8
Evening Classes	80	54
Others	10	6

Table 14.10: The most desirable level that biology teachers would like to allocate all their weekly time-tables to teach

Level	Number of teachers choosing the level	Percent
Guidance Cycle	2	1.4
First Year of Secondary	30	20.4
2nd & 3rd Year of Sec.	62	42.2
Sixth Year	23	15.6
Normal School	3	2.0
Guidance T.T.C.	5	3.4
Others	2	1.2
Non-respondent	20	13.4
Total	147	100.0

There are several reasons, indicated in teachers' interviews, that lead the biology teachers to teach at the higher grades:

(1) The differentiated fee for an hour's teaching at different levels of the educational system is the most dominant factor.

The biology teacher's salary is based on teaching 24 hours in a week. In addition to this 24 hours, teachers can have up to 12 hours extra teaching to be entitled to a full-time salary. However, the full-time teacher may still have extra hours in a week to teach (Iranian schools operate six days per week and mostly have up to 8 sessions in a day) at higher grades.

Data obtained from the teachers showed, on average, they are teaching 35.0 hours in a week with 20 (3 individuals) to 70 (1 individual).

(2) The final years of the new system of education and those of the old system have always been treated as highly important since the students have to pass a national examination. This examination not only assesses the students' achievement but also evaluates teachers' performances. The proportion of students who pass and go to a higher education institute is a good way for a teacher to establish a reputation. Once a teacher has established a reputation he can choose the levels he teaches and bargain for other privileges.

(3) In spite of the high fee paid for teaching at some of the teachers' training institutes, teachers did not choose these as their most desirable grade to teach (see Table 14.10). This attitude contributed to several factors that were revealed in teachers' interviews. The most obvious factor was the low status of the teaching profession and the gradual quantitative degrading of the teachers' training curricula. It is true that every general director at a Department of Education tries to allocate the best teachers to these institutes. However, the stagnation of the teachers' training curricula and the alienation of their aims towards the need of the educational system is well known amongst teachers. There is "no challenge", biology teachers declared, "to teach at these insti-

tutes. Their environments of teaching and learning are identical to those of the secondary schools. Students are more demanding and have less discipline."

14.4.3

Some teachers had other responsibilities in addition to teaching. Table 14.11 shows that all of these jobs were administrative jobs at various parts of the system of education. However, when they were asked if they preferred any other job they chose teaching. A few were not content with their job or their salary and wished to be able to find other jobs outside the Ministry of Education (Table 14.11).

The above data shows few teachers believe that their job is not a well-paid job. However, they know that there is no escape from the Ministry of Education if they wish to seek other employers. This is because of the acute shortage of science teachers and the prohibition imposed by the government to other government Ministries not to employ a resigned science teacher. In recent years no request for resignation was accepted either.

14.5 Teachers' Attitudes towards the Biology Curriculum and the Textbook

Several items were used for measuring teachers' attitudes towards the biology curriculum and the textbook. Some of these items were acting as a check for consistency of the teachers' responses to earlier items.

In questions 13-14, teachers' first attitudes towards the biology curriculum and the biology textbook was asked.

Table 14.11: Teachers' responsibilities other than teaching and their alternative 'ideal' job situations.

Responsibilities	Number of teachers choosing this category		Alternative 'ideal' job	Number of teachers choosing this category	
Head	25	17.0%	Teaching	102	69.4%
Deputy head	3	2.0%	Highly paid job	4	2.7%
Administrator	3	2.0%	Administrator	8	5.4%
Others	7	4.8%	Anywhere except at the Ministry of Educ.	8	5.4%
None	106	72.1%	Others	11	7.5%
Non-respondent	3	2.0%	Non-respondent	14	9.5%
Total	147	100.0%	Total	147	100.0%

The same question was repeated to obtain teachers' impression of his colleagues' attitudes toward the same categories. In question 18 teachers' present attitudes towards the new biology curriculum was questioned. Questions 29 and 30 ask the teacher to rate his interest and those of his students in teaching and learning ecology (see Appendix 7 for the original questions).

Some of the data obtained from these questions can be found in Table 14.12. A study of the mean value of scores obtained from the above questions shows that:

1. Teachers were more optimistic about the new biology curriculum before the publication of the student textbook.
2. The same attitudes were expressed for their colleagues. The lower standard deviation obtained from teachers' attitude scores given for their attitude to the textbook indicates that they were more consistent in their responses.

Results obtained from analysis of question 18 showed that, even after three years, teachers' attitude toward the biology curriculum has not been changed.

Teachers rated themselves more interested in teaching ecology than students would be in learning this subject. This result was represented by a higher value of the mean score obtained for question 30 (M = 4.5) than question 29 (M = 3.6).

A comparison between the mean value of scores obtained from the responses to the above questions from male and female teachers suggested that:

Table 14.12: Some data obtained from teachers' questionnaires

	Mean	S.D.	S.E.	Median	Max. Diff.	K-S	2-Tailed P.	r	Response distribution				
									1	2	3	4	5
Attitude 1	3.61	.99	.08	3.82	.47	5.56	0	-	2.2	15.9	14.5	52.9	14.5
Attitude 2	3.29	1.03	.09	3.61	.36	4.17	0	-	3.1	26.6	14.8	48.4	7.0
Attitude 3	3.55	.90	.07	3.55	.47	5.57	0	-	12.9	35.0	36.4	35.4	15.7
Attitude 4	3.27	.80	.07	3.26	.42	4.78	0	-	00	17.8	41.9	35.7	4.7
AIMD 1	4.38	.76	.06	4.58	.64	7.56	0	.49	00	.7	14.6	29.9	54.7
AIMD 2	4.13	.88	.07	4.25	.57	6.66	0	.53	00	5.2	17.2	36.6	41.0
AIMD 3	3.93	1.12	.09	4.15	.49	5.66	0	.62	3.8	8.4	18.3	29.8	39.7
AIMD 4	4.023	1.19	.10	4.36	.56	6.44	0	.67	6.2	7.8	9.3	31.0	45.7
AIMD 5	3.97	1.03	.11	4.52	.52	5.81	0	.67	7.2	11.2	9.6	20.8	51.2
AIMD 6	4.14	1.01	.08	4.41	.56	6.54	0	.69	2.2	5.2	16.3	28.9	47.4
AIMD 7	3.98	.93	.08	4.08	.53	6.02	0	.51	34.1	38.0	20.9	6.2	.8
AIMD 8	4.16	.97	.08	4.39	.57	6.62	0	.50	1.5	5.3	15.3	31.3	46.6
AIMP 1	2.71	1.09	.10	2.78	.23	2.58	0.0	.51	16.5	22.3	39.7	15.7	5.8
AIMP 2	2.58	1.13	.10	2.48	.22	2.43	0.0	.48	17.6	32.8	29.4	13.4	6.7
AIMP 3	2.27	1.01	.09	2.19	-.28	3.14	0	.51	25.4	35.6	28.0	8.5	2.5
AIMP 4	1.91	1.13	.10	1.57	-.36	4.05	0	.34	47.9	28.9	10.7	8.3	4.1
AIMP 5	2.42	1.30	.12	2.23	.20	2.15	0.0	.35	33.6	22.4	19.0	18.1	6.9
AIMP 6	3.33	1.13	.10	3.25	.38	4.23	0	.51	5.8	15.7	38.0	20.7	19.8
AIMP 7	3.09	1.18	.10	3.07	.30	3.42	0	.45	9.0	24.6	28.7	23.8	13.9
AIMP 8	3.60	1.13	.10	3.73	.43	4.74	0	.47	5.0	11.7	25.8	32.5	25.0
Opinion	3.52	.89	.08	3.63	-	-	-	-	.8	13.0	30.1	44.7	11.4
Students	3.61	.78	.06	3.64	.56	6.62	0	-	2.2	1.4	39.9	45.7	10.9
Teacher	4.37	.86	.07	4.57	.69	8.35	0	-	2.8	.7	6.9	35.4	54.2
Need 1	3.37	1.09	.09	3.32	.41	4.71	0	-	5.3	13.6	37.9	25.0	18.2
Need 2	3.32	1.17	.10	3.37	.39	4.56	0	-	9.6	11.1	33.3	28.9	17.0
Need 3	3.38	1.17	.10	3.42	.39	4.54	0	-	8.3	12.1	31.8	28.0	19.7
Need 4	3.85	1.10	.09	4.00	.48	5.59	0	-	3.0	8.9	23.7	28.1	36.3
Need 5	2.60	1.14	.10	2.60	.48	5.59	0	-	19.7	26.8	33.1	14.2	6.3
Need 6	2.43	1.70	.11	2.20	.20	2.25	0.0	-	30.7	27.6	18.9	13.4	9.4

1. Female teachers were more consistent in their attitudes towards the biology curriculum and the textbook. This is well expressed by the low values of standard deviation from their scores.
2. They did not maintain a consistent attitude towards the biology curriculum today.
3. They were less interested in teaching ecology but they believed students were more interested than themselves in this subject. This result was identical to the male teachers' responses.

Table 14.13 summarizes details described above.

Table 14.13: Mean and standard deviation of the scores obtained from responses by the male and female teachers in questions 13, 14, 18, 19 and 20.

Item	Sex	Mean	S.D.
Attitude 1	Male	3.60	1.01
	Female	3.63	.92
Attitude 2	Male	3.26	1.07
	Female	3.38	.86
Attitude 3	Male	3.58	.89
	Female	3.40	.97
Attitude 4	Male	3.33	.80
	Female	3.00	.78
Student's interest	Male	3.64	.83
	Female	3.42	.50
Teacher's interest	Male	4.38	.90
	Female	4.32	.72
Question 18	Male	3.50	.85
	Female	3.64	1.03

14.6 Biology Teachers and the Curriculum Goals

In 1973, when the new biology curriculum was developed, copies of this curriculum and the description of its goals were sent to each Department of Education. It was hoped that teachers could have an opportunity to scrutinize this curriculum before its implementation.

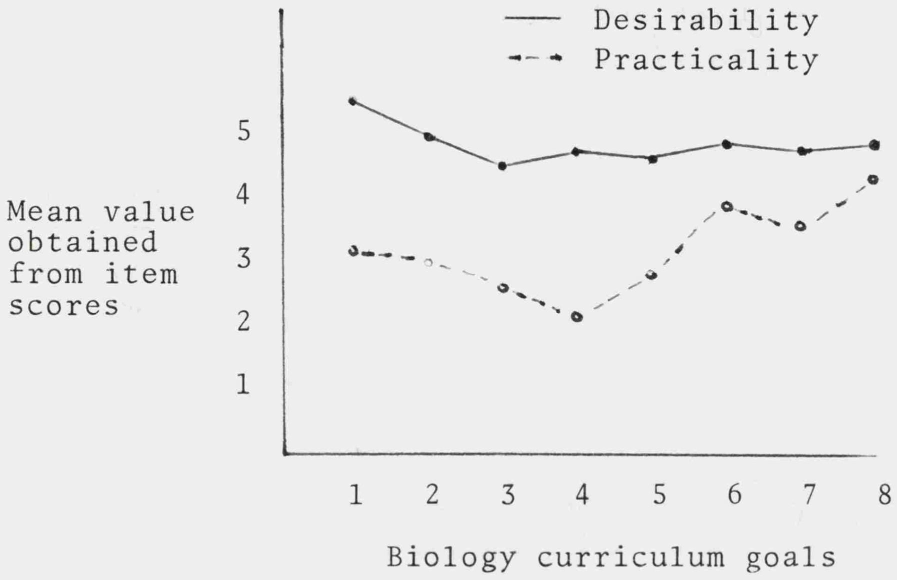
In the next four years few responses from the biology teachers were received by the Curriculum Planning and Research Centre. In the in-service courses teachers were again introduced to the details of the biology curriculum and its goals were fully described.

During the pilot study it was understood that the biology teachers were already familiar with the curriculum goals. A pilot run of these goals was conducted on a small group of teachers to investigate their responses to these goals and the rate of postal questionnaire response. These teachers were selected from the list of those attending the first in-service courses in Summer 1974. In this process, table of random numbers was used to choose the required number of teachers from the list. Results of this investigation can be found in Chapter 6, Pilot Study, pp.173-175.

Question 15 on the teacher questionnaire is the application of the same instrument. The biology teachers in the sample had to rate desirability or practicality of each goal on a Likert-type scale of 1-5 points. The scores obtained from these teachers were converted into mean and standard deviation and were finally ranked against these values.

Figure 14.14 suggests that there is a distinctive gap between desirability of the curriculum goals and their

Figure 14.14: Results obtained from teachers' desirability rating and practicality of the biology curriculum goals on a Likert-type scale.



practicality in schools. However, this gap between the curriculum specific objectives is not as much as indicated for curriculum goals.

Ranking the above results by the use of mean values obtained for each category leads to the data represented on Table 14.15. These results suggest that:

1. Teachers strongly believed that the curriculum specific objective number 2 (goal no.8) was highly desirable and practical. This view was not shared for specific objective on similarities and diversities of living organisms. In this case the desirability of the objective was rated very low. But teachers believed that its achievement is not difficult in their schools.
2. Teachers were aware of the importance of the development of scientific attitudes but did not think this goal could be achieved in their schools. Comparison between results obtained from field work and pilot study shows that teachers' view on this goal has dramatically changed. This change should be attributed to the effects of the in-service courses, teaching experience with the curriculum and textbook etc.
3. Teachers did not believe that the biology taught in school had any application in students' daily life. In their schools, it was not difficult to achieve this view. In the pilot study they had different views about this goal.

Table 14.15: Ranking the results obtained from the biology teachers rating the desirability and practicality of the curriculum goals and their attribution in the biology textbook.

Goals	Results obtained from the field work		Results obtained from the pilot study		Attributed to the biology textbook
	D(1)	P(2)	D(1)	P(2)	
1. Scientific attitude	1	5	3	2	2
2. Problem solving	4	6	4	3	5
3. Applying his knowledge	8	4	2	5	6
4. Using labs. equipment	5	8	7	8	7
5. Safety in the lab.	7	7	8	8	7
6. Technical terms	3	2	6	6	1
7. Similarities & diversities	6	3	5	4	3
8. Status of man	2	1	1	1	4

(1) Desirability

(2) Practicality

4. They believed that students should be encouraged to become familiar with scientific terminology and they practiced this goal in their schools (goal no.6).
5. The experimentation and safety of using laboratory materials and equipment was neither a practical nor desirable goal in the present situation. This conclusion stems from the lack of the laboratory materials which had nullified the relevance of these goals in the teaching and learning of the new biology curriculum.

When the same group of teachers were asked to indicate to what extent the above goals were dispersed in the biology textbook, different rank order was obtained from the analysis of their scores.

They believed that the textbook had used sufficiently technical terms and had been designed to create scientific attitudes in the students. However, the laboratory experiments and safety in the laboratory sections were not fully implemented.

14.7 Teaching and Learning the Biology Curriculum

In question 19 teachers were asked to indicate, on a check-list, what type of difficulties they had when they first started to teach the biology curriculum. In question 20 they were asked to answer which of the difficulties that they had indicated previously still persisted.

Results of the above two questions are tabulated on Table 14.16. These results suggest that most of the teachers' difficulties which still persist are those concerned with:

Table 14.16: Difficulties in implementation of the new biology curriculum.

Difficulties	Difficulties in curriculum implementation					
	At the beginning of the Course			After two years		
	Number of teachers	Percent	Rank	Number of teachers	Percent	Rank
Knowledge of ecology	21	14.3	7	9	6.1	8
How to do experiments	37	25.2	5	25	17.0	6
Have no lab. equipment	125	85.0	1	106	72.1	1
No space for experimentation	108	73.0	2	96	65.3	2
Could not answer questions	18	12.2	8	14	9.5	7
Had no references	99	67.3	3	87	59.2	3
A large no. of students	93	63.3	4	81	55.1	4
Others	35	23.8	6	30	20.4	5

1. Lack of laboratory equipment and materials.
2. Lack of space to perform experiments.
3. Lack of reference books.
4. The existence of large numbers of students in each classroom. Even after three years of teaching most of the same problems still persist.

Having specified their difficulties in teaching the biology curriculum, teachers were asked to specify what method of teaching they had adopted in their schools. Details in Table 14.17 show that most of the teachers adopted the lecture method and made students read through the text afterwards. Some teachers had abandoned the textbook and dictated their own versions. Few used the textbook and carried out as many experiments as they could.

Table 14.17: Various teaching methods used by the biology teachers.

Method	Number of teachers choosing this category	Percent
1. Students read, teacher describes.	35	23.8
2. Teacher describes, students read.	79	53.7
3. Teacher dictates a summary.	8	5.4
4. Teacher dictates questions and answers.	13	8.8
5. Teacher dictates basic details.	15	10.2
6. None of the above	25(1)	17.2

(1) Some teachers chose two categories to describe their methods of teaching as the result of their dissatisfaction with the description in the table above.

These results show teachers are using several teaching methods according to their ability and the conditions in which they are operating. Therefore student population in the achievement test differs in terms of the instruction they receive from their teachers. This assumption, already proved in the details of the achievement technical report, has various effects on students' achievements.

In the questions 24 to 28 teachers answered various inquiries about how they used materials in the textbook. It was predicted that some of the teachers might not be satisfied with the description given in question 23, of their teaching method, and might choose two categories to specify their method of teaching. So in question 24 they were asked to describe their teaching method in some detail. The results obtained from this question were used to check the consistency of the scores obtained for the previous question.

Question 25 was concerned with how teachers used the textbook. In answering how they treated the "question and self assessments" at the end of each chapter, 23.8 percent used these questions for students' homework, 58.5 percent used them as class exercises and 1.4 percent as project work. This last category was chosen by those teachers who had used experimental and Socratic method of teaching.

In describing how they used the experiments in the textbook, 1.4 percent claimed to use them as group work, 42.2 percent as class demonstration by the teacher, 5.4 percent performed them in the laboratory (mostly in central laboratories).

The references at the end of each chapter were also used differently by different teachers. 29.5 percent of the teachers recommended the references to their students, 4.8 percent of the teachers read them themselves and used them as additional sources of knowledge, 68.7 never used them.

The field work section in the ecology teaching was treated worst. 72.8 percent of the teachers had not carried out any field work. 19.7 percent took students to see local factories. However, this activity was not related to ecology, but was a general school policy to acquaint students with local industries. 1.4 percent tried some exploration in the school yard and another 1.4 percent gave students some field work. 7.5 percent of schools tried a combination of field work and small investigations in the school yard.

In questions 26 and 27 teachers rated the textbook experiments that could be best done in their schools or could be used for teaching a difficult concept.

46 percent of the teachers indicated that a particular experiment could be used in their schools. 35 percent believed they could be useful to help students understand a difficult concept and principle. Table 14.18 provides details of the teachers' response to these questions.

In question 28 teachers were asked to answer a checklist about students' difficulties in learning ecology. The results obtained from teachers' scores suggested that most of the students' difficulties were related to the interrelation between chapters in the textbook. This was indicated by about 47.9 percent of the teachers. 32.7 percent of

Table 14.18: Teachers' opinion about practicality of the textbook experiments and their use in teaching a concept or principle.

N = 147

Name of the experiments	Practicality		Teaching Value	
	Number of teachers	Percent	Number of teachers	Percent
Bromo-Thymol	6	4.0	1	.6
Ingenhouz	3	2.0	2	1.0
Starch test	18	12.0	3	2.0
CO_2, starch formation	1	.6	2	1.0
Chromatography	15	10.0	-	-
Photography with leaf	-	-	-	-
Bread mould	2	1.0	1	.6
Air pollution	-	-	1	.6
Earthworm pop. density	-	-	3	2.0
Sampling method	3	2.0	14	9.0
All	15	10.0	18	12.0
None	80	54.0	97	65.9
Total	143	95.6	142	94.7

the teachers indicated students' difficulties are due to their inability to understand the textbook. 22.4 percent found students unable to apply the ecological terms in new situations. 9.5 percent noticed that some students have difficulty in reading the textbook. However, amongst other reasons given by the teachers (15.0 percent of the teachers), the following factors were effective on student learning:

1. The persistence of traditional method of learning in school.
2. Lack of resources and references for further study.
3. Lack of sufficient background in students' biology knowledge.
4. Lack of relation between various syllabi in the school curriculum.
5. Late arrival of the textbooks (in some cities five months after the beginning of the academic year).
6. Lack of laboratory and equipment for doing experiments.
7. Lack of enough time to finish the book.

The last factor was recalled in every occasion by the teachers as the main factor inhibiting them to teach the new biology curriculum in depth. Results obtained from question 24 shows that on average, the teachers in the sample had spent 15 weeks to finish the section on ecology. This figure had a range of 4 to 34 weeks, indicating that most of the teachers had great difficulty in pursuing the Ministry of Education regulation for finishing the textbook. In fact, at the time of the field work and the pilot study (six months after the beginning of the academic year), most of the schools had recently completed the section one on ecology.

14.8 In-service Courses

The original list of the teachers was obtained from the Department of In-service Training at the Ministry of Education. The teachers on the list had taken part in at least one specialized in-service course for teaching the new biology curriculum.

Questions 32 and 33 were intended to investigate the validity of the above list and consequently the sampling. Results obtained from these questions showed most of the biology teachers had attended many in-service courses (3 on average) including at least one specialized course for teaching the biology curriculum. In these courses most of the emphasis was made on ecological knowledge (m = 3.37), how to do experiments (m = 3.32), or how to teach the new curriculum (m = 3.38), and answering the questions at the end of each chapter (m = 3.85). The study of various methods of assessment and how to find references were not treated to the same extent (mean 2.60 and 2.43).

14.9 Summary

The teachers' questionnaire was developed from the results of the data obtained from the curriculum and goal analysis from the biology curriculum. In the pilot study further information became available for justification and specification of the problem areas chosen for the construction of teachers' questionnaire.

The teachers' questionnaire developed by the above procedure had four sections about various aspects of the biology teaching and learning in schools. Results from the questionnaire suggested that:

1. Teachers are mostly overworking and teach more than 36 hours per week. They teach in a variety of institutes and at different grades. But they are mostly interested in teaching at higher grades in the secondary schools where the tuition fees are higher and teachers' performances bring them reputation and status.
2. Teachers showed a different attitude towards the curriculum and towards the textbook. They were mostly less interested in teaching ecology than their students and believed that curriculum specific objectives were more practical in their school situations.
3. The greatest difficulties in teaching the new curriculum were related to the lack of a laboratory and reference books, and the existence of the crowded classroom. They used a variety of teaching methods, but mostly the lecture method, for coping with their environment.
4. In using the textbook few teachers had carried out experiments as a group activity, to recommend and read the reference books, or conduct a piece of field work.

5. All the teachers had attended at least one specialized in-service course in which they had done the experiments, discussed the questions and attended lectures about ecological principles. The methods of assessment and ways of finding references were treated to a lesser extent here.

References and Notes on Appendix 14

1. OPPENHEIM, A.N. (1966). *Questionnaire design and attitude measurement*. pp.65-66. London: Heinemann.

2. *Ibid.*

3. SELLTIZ, Claire. *et al.* (1951). *Research methods in social relations*. Revised edition. London: Methuen & Co. Ltd.

4. *Ibid.* pp.552-572. In these pages some questions about questionnaire items have been proposed to scrutinize their item-objective congruent and review them for any flaw in wording, grammar and language.

5. PALUMBO, J. Dennis. (1969). *Statistics in political and behavioural science*. p.358. New York: Appleton-Century-Crofts.

6. WOLF, Richard M. (1974). Data analysis and reporting consideration in evaluation. In: Popham, W. James (ed.) *Evaluation in education: current application*. pp.205-242. Berkely, California: McCutchan Publishing Corporation.

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APPENDIX 15

STUDENTS' QUESTIONNAIRE - TECHNICAL REPORT

The students' questionnaire was developed to supplement the responses obtained from the teachers' questionnaire and also to provide information about other aspects of the curriculum.

The few interviews with students, during the pilot study, showed that study of the attitudes towards school and the subjects is time consuming. The results obtained from those interviewed also showed that the students' attitudes were shaped by the system of values existing in their culture and society, rather than by the curriculum they had studied (Chapter 6, pp.160-161). However, their attitude towards ecology was dominated by their attitude towards hygiene, which they were studying in the second part of the biology textbook (Chapter 6, p.161). It was therefore decided to exclude attitude studies from the students' questionnaire in the field work (experimental stage) stage.

On the whole, it was concluded that (in the presence of their classmates) students were better in writing than expressing themselves orally. The paper and pencil instrument provided them with a sense of security which, with a little persuasion, could induce them to express their real attitude and knowledge. They were, however, quite helpful in discussing their difficulties in the text and those aspects of the course which they found difficult and ambiguous.

15.1 Development of Students' Questionnaire

The students' questionnaire was developed to answer the following questions:

1. Which of the affective objectives in the textbook have been achieved by the students?
2. Which of the psychomotor objectives have been achieved?
3. How did they carry out activities in the textbook, i.e. experiments, references etc?
4. Which part of the textbook was difficult and which part interesting?

The questionnaire was supplemented by interview with those who answered the questions.

The affective and psychomotor objectives of the textbook (Appendix 10, Table 10-7,10-8) had been derived from the details of the goal analysis. Two affective objectives seemed to be more as curriculum specific outcomes than the others: (a) attitude of students towards atomic explosion; and (b) attitude towards population control.

In recent years the Iranian government had launched a campaign against population explosion. Also in recent times several contracts for buying atomic reactors were signed. These factors had initiated the publication of various articles in newspapers and journals. Therefore, any measurement of the above attitude could not provide a 100 percent data about the curriculum effect.

On the other hand, students had scarcely answered any questionnaires. They were handicapped by their inability to cope with complicated scales and checklists. Study of some of the results obtained by M.Ed. students in the same area, had shown that much time was needed for explaining the characteristics of the scale when it is used to measure students' attainment.

It was therefore decided to use open-ended and short-answered questions, similar to those students were answering in their internal examinations, and accept their answers when they have been argued in terms of ecological concepts and principles. This strategy could prevent the problem of coping with the instrument. It also could differentiate student responses resulting from the effect of the curriculum from those developed by the effect of media.

One of the psychomotor objectives was that "students should be able to draw a simple diagram accurately". To investigate the achievement of this objective, students' workbooks were inspected, in cases where they used one.

In this respect the item in the questionnaire was the source of providing preliminary information for measuring the above objective.

The rest of the questionnaire was designed to investigate different aspects of the textbook activities.

The most important factor in the development of the students' questionnaire was that it should be short, since it was designed to be used at the end of the achievement test session and on a selective population of students (see the sampling procedure below).

The students' questionnaire began with an introduction to describe the reasons for the investigation, and to ask for the students' cooperation. The first eight questions concerned students' activities in relation to various parts of the textbook. Then the questions (except for no.3) were short-answer items. Question 3 was a checklist in which students had to confirm or reject whether they had carried out the textbook experiments, and the situation in which they had performed them (see Appendix 8 for details of these questions).

Questions no. 9 and 10 were as follows:

Question 9 - What is your attitude towards atomic explosions: should they be banned? Why?

Question 10 - What is your attitude towards population control? Should the population of Iran be controlled? Why?

These questions were both open-ended and short-answer items. Students not only had to answer whether they had positive or negative attitudes but also had to describe their reasons for their choice in terms of the ecological phrases.

15.2 Sampling Procedure

It has been shown (Chapter 6, p.161) that students were not able to answer factual questions if they were not knowledgeable about their details. In interviews with students this was also true. The experiences of the headmasters, teachers and other administrators confirmed this conclusion.

The sampling for the students' questionnaire was, therefore, limited to the top students in each sample group. The procedure of choosing these individuals was as follows:

When the achievement test was presented to a group of students, it was assumed that the most able students would finish the test earliest. These early finishers could be asked to answer the questionnaire while the other students were still answering the achievement test items. In order to confirm that these students were the most able ones, their answer sheets were thoroughly checked.

This strategy had merits:

1. It could prevent students from going outside and making a noise to disturb other classes.
2. It could prevent students from chatting with each other when they had finished the test, and thus exercised discipline.

In each sample group, up to five questionnaires were used. Sometimes extra copies of questionnaires were given, as dummies, to exercise discipline amongst other less able students who had finished the test early. These latter questionnaires were discarded afterwards.

When the testing was finished the students who had answered the questionnaire were interviewed, to clarify their points about each question. This interview was carried out in a group so that factual responses about the reality of their achievement could be checked and corrected by the others.

130 students were sampled from the 43 schools. In spite of the effort made to obtain equal samples from each individual school, there were variations. Most of the variations were due to the existence of a number of non-respondents for individual items or the whole questionnaire. In some cases a questionnaire had to be discarded because of its invalid responses that revealed themselves through the follow-up interviews.

On the whole the sample was biased towards the most able students. It could be argued that it did not represent the whole population under study. This argument can be challenged on the grounds that in factual questions like those concerning achievement of specific experiments, a census of opinion from the knowledgeable sample was more valid than that from a mixture of students. This procedure provided more consistent results than were confirmed in the interviews that followed.

15.3 The Analysis of the Students' Questionnaire

15.3.1

The first three questions were concerned with the use of the references in the textbook. Students were asked to name these references and indicate if they had studied them:

(a) because of their own interest, and

(b) because of their teacher's recommendation.

In Table 15.1, results obtained from 43 schools are tabulated. These results suggest that few students ever tried to read anything other than references in the textbook. When they did, in 72.6 percent of the cases, it was due to their own initiative rather than from teachers' recommendations. It is therefore concluded that the textbook had been relatively successful in making those students interested in reading further, but the role of the teacher was passive.

The indication of only few references by the students is the result of several conditions existing in the school and society:

Table 15.1: List of reference books students had read as a result of their own interest or teachers' recommendation.

Number of schools = 43   Number of students = 130

Name of the book	Own interest	Teacher's recommendation	School code number
Title unknown	-	-	1
The man unknown	x	-	3
Title unknown	-	x	5
Title unknown	x	-	8
North Pole	-	x	15
Geology	x	-	15
The ant life	x	-	18
The science of body			19
Our environment			
The science of ecology	x	-	
The science of ecology	x	x	22
The life in universe	-	x	23
General knowledge - Behdad	x	-	23
Biology amusements	x	-	24
Insect life			24
Searching for live fossils	x	-	
Plants and their miracles	x	-	24
Title unknown	-	x	28
Photosynthesis	x	-	33
Only one earth	x	-	33
Photosynthesis	x	-	33
Biology for the sixth forms	x	-	38
Animal biology	x	-	40
Scientific sokhan	x	x	40
Desert animals and birds	x	-	41
21 students/18 books	17 or 72.6%	6 or 27.4%	15

1. In a minority of schools an operational school library exists. In most of the schools visited during the pilot and experimental stage, the school library consisted of a few books kept in a cupboard, either located in the headmaster's room or the teachers' common room. Most of the books were for general reference and were about religion, philosophy, literature, history etc. Few biology or science books exist on the lists that students could borrow. In many cases one should follow a tedious bureaucratic procedure until he could borrow a book.
2. In most of the state capital cities there is a public library which is used as a place where students can get together to discuss their study problems, e.g. solving mathematics quiz. These libraries are mostly run by members of staff who rarely have any dynamic policy to introduce students to the potential use of the library for their studies.
3. In recent years, the number of new books published in Iran was decreased. The political environment discouraged the inquisitive minds that may seek a variety of information. As the result of this policy, teachers became reluctant to encourage their students to read varieties of references.
4. A glance through the city bookshops showed their stocks were very poor in terms of biological references. Most of the books were about religion,

history, western philosophy, fantasy, and sexual relationships. The number of bookshops was few and the price of the existing books very high.

15.3.2

Question 3 was concerned with the way textbook experiments were used. In few schools seven experiments, out of the ten on the list, were tried in groups. The most popular of these were:- the sampling method; chromatography; starch test; and Bromo-Thymol blue experiment (Table 15.2).

The majority of schools performed these experiments as class demonstrations or home-work activities. Chromatography was the one which rated high in all experimental situations. In many schools the chemistry teacher had also carried out this experiment in connection with a topic. This experiment was very simple, quick to work, and easily understood.

The next most popular experiment was the sampling method which was essential to understand the concept of sampling.

The Bromo-Thymol blue or bicarbonate experiment was rated moderately. The material for this experiment was distributed amongst teachers attending in-service courses. Therefore, most of them could carry out this experiment in their classrooms.

The few schools which had access to the laboratory, usually a central one, had tried a few experiments.

Most of the experiments named above were used by teachers who had combined experimental work with their instruction. In other cases the teachers' demonstration or students' activities at home were aimed to provide a basis for giving

Table 15.2: Number of schools in which textbook experiment had been carried out: in groups; by the teacher; at home; or in the laboratory. (1)

Experiments	Number of schools			
	Group activity	Teacher demonstration	At home activity	Laboratory
1. Bromo-Thymol blue	4	6	4	3
2. Ingenhouz	2	5	4	-
3. Starch test	5	6	7	-
4. CO_2, starch formation	-	2	4	2
5. Chromatography	6	9	8	5
6. Photography with leaf	-	3	4	-
7. Bread mould	1	3	8	-
8. Air pollution	-	-	-	-
9. Earthworm pop. density	3	1	8	-
10. Sampling method	6	5	10	2

(1) Number of schools in this study was forty-three. They were randomly selected from four state capital cities.

students laboratory marks, a requirement which had been imposed by the Ministry of Education.

15.3.3

Questions 4, 5 and 6 were concerned with other experiments, films and the field trips. Table 15.3 summarizes the results obtained from 43 schools. It can be seen that few schools tried counting red blood cells, an experiment suggested by the textbook as an application of the sampling method. A few schools exhibited the structure of a leaf or blood circulation in a fish tail, under microscope. The first experiment is relevant to the subject of photosynthesis but the second had no connection with the ecology syllabus. According to Table 15.3, only 16 students (out of 130 in 43 schools) had seen the films on ecological topics shown on T.V. This suggested that teachers had not recommended the programmes to their students and few of them made use of these films as teaching and learning materials. Interviews with teachers revealed that they had no time to watch the films, and discussion about the film was avoided since the majority of the students had not seen them either. However, they did know that several films were specially shown for their benefit (see also Chapter 6, p.176).

The field work, which was essential to make students acquainted with varieties of ecosystems, was ignored in all the 43 schools. Some schools had taken students out to visit local factories.

Several factors have been found to be responsible for the unpopularity of the field work in schools. The most important of them seemed to be the shortage of time. Due

Table 15.3: Results obtained from students in 43 schools who responded that they had conducted other experiments, seen a specific film or T.V. programme, or had been taken to a field trip.

N = 130 students[1]

Other experiments	Films	Field trip	School code number
Nil	"Parasites" "Evolution" "Man and Animals"	Visit to local factories	1
Counting red blood cells at the local hospital laboratory	T.V.: "Survival"	Nil	3
Nil	T.V.: "Survival"	Nil	5
Blood-grouping Transparency of the digestive organs	Nil	Visit to Iran refinery factory	8
Nil	T.V.: "Science"	Nil	15
Structure of leaf under microscope	T.V.: "Survival" "Plant Growth"	Nil	18
Blood grouping	Nil	Nil	19
Nil	T.V.: "Survival" "Science"	Nil	22
Blood circulation in a fish tail	T.V.: "Survival" Local Cinema: "White Wolf"	Nil	24
Counting red blood cells (at home)	T.V.: "Survival" School: "Pollution"	Nil	27
Nil	T.V.: "Science" "Fish Farm"	Local plywood factory	28
Nil	T.V.: "Survival" "Science"	"	33
Nil	T.V.: "Survival"	Nil	38
Nil	T.V.: "Survival"	Nil	40
Nil	T.V.: "Survival" "Science"		43

(1) Number of students who had seen the films = 26. These students came from the 43 schools investigated for students' responses on the above items.

to their heavy workload, teachers had no free time to spend on field work. The Department of Education was not convinced of the educational value of the field work for enhancing better learning of the subject. As a result the authorities were not willing to pay for extra time and expenses teachers incurred preparing and organizing the group activities, visiting the places, going on the actual field trips, and following up the outcomes in classroom projects.

All these procedures, in the minds of the administrators, were treated either as: (a) a luxury; or, (b) an excuse for the teacher not to perform his duty; or, (c) the cause of excessive amounts of trouble and responsibility that could be avoided by rejecting teachers' requests for permission to carry out field work.

15.3.4

Question 7 was about students' workbooks. Students in few schools had a workbook. Many schools had notebooks in addition to the workbooks. In the Farsi translation of the question, the phrase "Natural history workbook" had been used. This phrase was applied to the workbook traditionally prepared in the old system of education to draw illustrations, write questions and answers, and extra material about the subject.

The objective of this question was to investigate the achievement of psychomotor objectives, i.e. ability to draw some simple illustrations accurately.

In the few schools which had the workbook, students were required to draw textbook illustrations and teachers' drawings from the blackboard. The students' drawings were used

Table 15.4: Had students in the 43 schools any workbook? What did they write in their workbook, and from where did they obtain their illustrations?

What did they write in the workbooks?	Had they a workbook?	Source of illustrations	School code number
Illustration only, varieties of producers, consumers and decomposers.	Yes	Copied from the textbook or teachers' drawings on the blackboard	1
a) Questions and answers. b) Homework, i.e. questions. c) Summary of basic concepts. d) Materials dictated by the teacher.	Yes	as above	3, 27, 28
a) Summary of each lesson. b) Details of the experiments done in the classroom. c) Questions and answers from the textbook.	Yes	as above	5
a) Summary of each lesson. b) Additional material dictated by the teacher. c) Textbook questions.	Yes	Textbook Blackboard Charts	8
Textbook illustrations specified by the teacher.	Yes	Textbook only	15
a) Questions and answers. b) Notes from lessons. c) Illustrations.	No	Teachers' drawings	18, 23, 24 40
a) Notes	No	Teachers' drawings	19, 33
a) Notes on lessons. b) Additional material dictated by the teacher. c) Dried plants and flowers.	No	-	22 38 43
a) Notes on each lesson. b) Prepare a summary for each chapter content.	Yes	Textbook Teachers' drawings	35

(1) The remaining schools had not performed any of the above activities.

for giving their laboratory activities grade. In these cases no experiments had been carried out. The quality of drawings and illustrations depended on how much credit teachers gave for their preparation. When students did not have to prepare a workbook that was to be marked for laboratory activities, the quality of their drawings were of a low standard.

In general the unpopularity of simple illustration in students' workbooks was due to the attitude of the biology teachers towards them. Teachers were complaining that the biology textbook had no illustrations similar to the textbook of the old system of education, i.e. those illustrations that could be used to test students' visual memories. Teachers did not seem to appreciate the potential use of the simple diagrams in teaching.

In the last 4 years, however, a few teachers had started to use textbook diagrams and had created simplified versions for their teaching.

Table 15.4 shows results obtained from students in 43 schools in response to queries on what activities had they registered in their workbook, where they had any. There was a correlation between teachers' methods of teaching and the activities students had carried out.

13.3.5

Question 8 was concerned with the way questions and self assessment at the end of each chapter in the textbook were used by students. The results shown on Table 15.5 suggests that the majority of schools (46.6 percent) had not studied these questions. The rest of the schools either used these questions as students' homework or class exercises. In most cases students had to prepare answers to these questions after the teacher's instruction. In the subsequent sessions they were discussed in the classroom. In some schools teachers used to dictate the right answers. Otherwise the suggested right answer by the class was registered for future reference. In very few cases (2.3) these questions were used as special assignments that could lead to the provision of obtaining a laboratory mark for its achievement.

Table 15.5: How did students in each school use the questions and self-assessments at the end of each chapter?

N = 43 schools

Total	As homework	As class exercise	As a project	Never studied
100.0 43	23.2% 10	27.9% 12	2.3% 1	46.6% 29

15.3.6

Questions 9 and 10 were supplementary questions for investigating students' attitude to atomic explosion and population control, in addition to those essay type questions they had to answer in separate sessions (see Chapter 6, p.160).

In the process of analysis of these questions, only those arguments which were based on ecological facts were included as the valid answer.

As a whole, 59.2 percent of the students were against any atomic explosion and had provided good reasons for supporting their opposition. This figure was equivalent to 75 percent of the respondents. In the same way, 83.8 percent of the whole population were against any increase in the population density in Iran and agreed with the application of control devices for the size of the families (Table 15.6).

Table 15.6: Students' attitude to atomic and population control.

N = 130

Item	Positive	Negative	Non-respondent
Atomic explosion	59.2%	20.7%	20.0%
Population explosion in Iran	83.8%	5.3%	10.9%

The most interesting reasons they provided for their answers to these two items are given below:

1. Atomic explosion experiments — Type of attitude

- It is always possible that some politicians exploit the result of these experiments against the welfare of human beings.	-
- They provide information for better understanding of the phenomenon and the advancement of the science.	+
- The results could be used for peaceful purposes, e.g. medical use, treatment of cancer etc.	+
- They provide alternative sources of energy which could be controlled and harvested	+
- They pollute ecosystems, destroy the producers and affect the consumers as well.	-

- By producing Strontium 90 and polluting the vegetation, they will endanger consumers' life including human beings. -
- The Japanese experience showed how dangerous their effects on various forms of life could be. -

2. Population control and Iranian population	Type of attitude
- Population increase leads to the shortage of food, housing and other resources.	+
- In Iran the present increase in population density had caused shortag of agricultural products, housing problems and traffic jams.	+
- The expansion of industry and the need of manpower requires the increase in population.	-
- The smaller the family size, the better education, standard of living and family welfare.	+
- The use of pills can control the family size.	+
- The control leads to less crowded classes and a better standard of education and the use of resources.	+

The above results showed that few students were against population control in Iran (Table 15.6). In fact recent devaluation of Iranian currency and the high rate of inflation, shortage of food resources, the high price of land and houses was so dramatic that it could not escape students' attention. They could see the effects of increased population on the quality of their daily life. It appeared that most of their needed commodities were imported, and certain agricultural products had disappeared from the market. The increasing number of students in the classroom was also the result of recent improvements in the health service that reduced child mortality rate, hence effecting a population increase.

Their attitude did not entirely result from the textbook they read. The fact that they used textbook terminology to express their observations in life and relate them to the concepts they had studied was considered to be a credit to the textbook's effect.

15.3.7

Questions 13 and 14 were about the difficulties students had encountered in the textbook and the parts of the book that they had found useful. Table 15.7 shows that the most difficult area in the textbook was the terrestrial ecosystem and the web of life. The most useful parts proved to be the Structure and Function of Ecosystem which has many applications in daily life.

These data have more application in evaluation study directed for course improvement. It also indicates which part of the textbook was insufficiently treated in the instruction in each individual school.

Table 15.7: Number of students that found a particular topic in the textbook, (a) difficult, and (b) useful.

Topics	Number of students finding difficulty	Number of students finding topic useful
1. General:		
Aquatic ecosystems	3	3
Ecosystem: structure	3	10
Interactions	2	10
Man and change of ecosystem	4	2
Population	3	5
Producers/Consumers	4	5
Terrestrial ecosystems	10	5
The web of life	10	16
2. Specifics:		
Agronomic	0	1
Chemosynthesis	4	0
Cycle of matters	3	3
Digestion	1	1
Food web	1	11
Leaf structure	2	0
Mutualism	0	0
Population change	1	2
Population density	2	4
Population	0	1
Pyramid of energy	1	2
Sampling	0	1
Succession	0	0
Photosynthesis	5	8
3. Experiments		
Bromo-Thymol	1	0
Ingenhouz	3	0
Van Helmonts	1	0

15.4 Summary

The students' questionnaires were developed to supplement some of the evidence obtained from teachers' interviews and questionnaires. It also provided a crude estimate of the achievement of several affective and psychomotor objectives. The results can be summarized as follows:

1. Several factors prevented students from studying references at the end of each chapter:
   (a) political factors and the lack of enthusiasm from the teachers,
   (b) the price of the books and the non-existence of functional libraries and resources.

   Therefore, few books were studied by few students in the sample as the result of their own initiative. However, books recommended by the teachers were used for assessing students' comprehension.
2. The extent of performance of experiments was limited by several intrinsic factors in the system. Some simple experiments were used in groups and by the teacher as well as students' homework. The existence of a laboratory mark endorsed recently by the Ministry of Education, had a great effect on the use of central laboratories where they existed. The majority of teachers, however, made students carry out experiments at home.
3. Few teachers used their initiative to introduce additional experiments suggested in the text. T.V. films on Natural History had been seen by several top students but they were not used as

educational material by their teachers. Field work was never used as a means of understanding ecological principles.

4. Students showed a clearly expressed attitude towards atomic explosion tests but their attitudes towards population control were affected by the campaign against population explosion and the recent economic inflation in the country. However, most students described experiences obtained from their environments using textbook concepts and terminology.

APPENDIX 18

SOME STATISTICAL PROCEDURES MENTIONED OR USED IN THE TEXT, IN ALPHABETICAL ORDER

	Title	Page
1.	Analysis of variance (ANOVA)	
2.	Chi-square test	
3.	Correlation	
4.	The Cox-Vargas difference indices	
5.	Difficulty index or item difficulty	
6.	Discriminant index (CRT)	
7.	Discriminant index (NRT)	
8.	Discriminant analysis	
9.	Frequency distribution	
10.	Index of item-objective congruence	
11.	Item facility	
12.	Item validity	
13.	Kolmogrov-Smironov (K-S) one sample test	
14.	Mean	
15.	Median	
16.	Mode	
17.	Pearson correlation	
18.	Point biserial correlation	
19.	Reliability	
20.	Skewness and Kurtosis	
21.	Spearman and/or Kendall rank-order correlation	
22.	Standard deviation	
23.	Standard error of estimate	
24.	T-test	
25.	Validity	
26.	Variance	

Analysis of Variance (ANOVA)

The analysis of variance was used, for interval scale data, to measure the effect of independent variables on the results of test items and the test as a whole.

In the process of ANOVA dependent variable was called Criterion and independent variable was known as a Factor. The ANOVA measured difference among several groups through the use of their variance. In this procedure the sum of squares of the criterion was decomposed into independent components. (1).

SSy = SS (between) + SS (within)

where: $SSy = \Sigma_j \Sigma\Sigma_i (Y_{ji} - \bar{Y})^2$.

In which $\bar{Y}$ is the mean of Y over the whole sample (known as the grand mean), and the summation were over individuals cases i in each category j of the factor A.

$$SS\ (between) = \Sigma_j N_j (\bar{Y}_j - \bar{Y})^2$$

where

$\bar{Y}_j$ = the mean of Y in the category j, and

N_j = the number of cases in category j.

And $SS\ (within) = \Sigma_j \Sigma_i (Y_{ji} - \bar{Y}_j)^2$

SS between was called SS_A. SS within is a variation which was not accounted by A and is called SS error. Therefore we can write the above formula as the following:

$$SS_y = SS_A + SS_{error}$$

The result was expressed in F value which was the ratio of the two variance estimates. (2).

$$F = \frac{SS_A/(K-1)}{SS_{error}/(N-K)} = \frac{MS_A}{MS_{error}}$$

where all the symbols mean exactly the same as those in the previous formula. The values of F for different degrees of freedom can be found in the Table A. Where the obtained value exceeds the corresponding one on the table, we assume that the null hypothesis was not true and there was a genuine difference between the groups involved.

The computation procedure for ANOVA were calculated in the following steps:

1. Total sum of squares was computed from the variation amongst scores without considering their group structures.
2. Within groups sum of squares was calculated from the variation existing within groups.
3. Between groups sum of squares was calculated from the sum of squares of the group means.
4. A degree of freedom was calculated.
5. The F ratio was calculated.
6. The significance of the F ratio was judged by the use of the Table A for the specified degrees of freedom.

In the analysis of variance it was assumed that the population under study were homogenous, normally distributed and groups were independently and randomly selected. (3).

Table A: 5 percent (Roman type) and 1 percent (bold-faced type) points for the distribution of F. (1)

n_1	n_1 Degrees of Freedom (for Greater Variance)																								n_2
	1	2	3	4	5	6	7	8	9	10	11	12	14	16	20	24	30	40	50	75	100	200	500	∞	
1	161 **4,052**	200 **4,999**	216 **5,403**	225 **5,625**	230 **5,764**	234 **5,859**	237 **5,928**	239 **5,981**	241 **6,022**	242 **6,056**	243 **6,082**	244 **6,106**	245 **6,142**	246 **6,169**	248 **6,208**	249 **6,234**	250 **6,258**	251 **6,286**	252 **6,302**	253 **6,323**	253 **6,334**	254 **6,352**	254 **6,361**	254 **6,366**	1
2	18.51 **98.49**	19.00 **99.01**	19.16 **99.17**	19.25 **99.25**	19.30 **99.30**	19.33 **99.33**	19.36 **99.34**	19.37 **99.36**	19.38 **99.38**	19.39 **99.40**	19.40 **99.41**	19.41 **99.42**	19.42 **99.43**	19.43 **99.44**	19.44 **99.45**	19.45 **99.46**	19.46 **99.47**	19.47 **99.48**	19.47 **99.48**	19.48 **99.49**	19.49 **99.49**	19.49 **99.49**	19.50 **99.50**	19.50 **99.50**	2
3	10.13 **34.12**	9.55 **30.81**	9.28 **29.46**	9.12 **28.71**	9.01 **28.24**	8.94 **27.91**	8.88 **27.67**	8.84 **27.49**	8.81 **27.34**	8.78 **27.23**	8.76 **27.13**	8.74 **27.05**	8.71 **26.92**	8.69 **26.83**	8.66 **26.69**	8.64 **26.60**	8.62 **26.50**	8.60 **26.41**	8.58 **26.35**	8.57 **26.27**	8.56 **26.23**	8.54 **26.18**	8.54 **26.14**	8.53 **26.12**	3
4	7.71 **21.20**	6.94 **18.00**	6.59 **16.69**	6.39 **15.98**	6.26 **15.52**	6.16 **15.21**	6.09 **14.98**	6.04 **14.80**	6.00 **14.66**	5.96 **14.54**	5.93 **14.45**	5.91 **14.37**	5.87 **14.24**	5.84 **14.15**	5.80 **14.02**	5.77 **13.93**	5.74 **13.83**	5.71 **13.74**	5.70 **13.69**	5.68 **13.61**	5.66 **13.57**	5.65 **13.52**	5.64 **13.48**	5.63 **13.46**	4
5	6.61 **16.26**	5.79 **13.27**	5.41 **12.06**	5.19 **11.39**	5.05 **10.97**	4.95 **10.67**	4.88 **10.45**	4.82 **10.27**	4.78 **10.15**	4.74 **10.05**	4.70 **9.96**	4.68 **9.89**	4.64 **9.77**	4.60 **9.68**	4.56 **9.55**	4.53 **9.47**	4.50 **9.38**	4.46 **9.29**	4.44 **9.24**	4.42 **9.17**	4.40 **9.13**	4.38 **9.07**	4.37 **9.04**	3.46 **9.02**	5
6	5.99 **13.74**	5.14 **10.92**	4.76 **9.78**	4.53 **9.15**	4.39 **8.75**	4.28 **8.47**	4.21 **8.26**	4.15 **8.10**	4.10 **7.98**	4.06 **7.87**	4.03 **7.79**	4.00 **7.72**	3.96 **7.60**	3.92 **7.52**	3.87 **7.39**	3.84 **7.31**	3.81 **7.23**	3.77 **7.14**	3.75 **7.09**	3.72 **7.02**	3.71 **6.99**	3.69 **6.94**	3.68 **6.90**	3.67 **6.88**	6
7	5.59 **12.25**	4.74 **9.55**	4.35 **8.45**	4.12 **7.85**	3.97 **7.46**	3.87 **7.19**	3.79 **7.00**	3.73 **6.84**	3.68 **6.71**	3.63 **6.62**	3.60 **6.54**	3.57 **6.47**	3.52 **6.35**	3.49 **6.27**	3.44 **6.15**	3.41 **6.07**	3.38 **5.98**	3.34 **5.90**	3.32 **5.85**	3.29 **5.78**	3.28 **5.75**	3.25 **5.70**	3.24 **5.67**	3.23 **5.65**	7
8	5.32 **11.26**	4.46 **8.65**	4.07 **7.59**	3.84 **7.01**	3.69 **6.63**	3.58 **6.37**	3.50 **6.19**	3.44 **6.03**	3.39 **5.91**	3.34 **5.82**	3.31 **5.74**	3.28 **5.67**	3.23 **5.56**	3.20 **5.48**	3.15 **5.36**	3.12 **5.28**	3.08 **5.20**	3.05 **5.11**	3.03 **5.06**	3.00 **5.00**	2.98 **4.96**	2.96 **4.91**	2.94 **4.88**	2.93 **4.86**	8
9	5.12 **10.56**	4.26 **8.02**	3.86 **6.99**	3.63 **6.42**	3.48 **6.06**	3.37 **5.80**	3.29 **5.62**	3.23 **5.47**	3.18 **5.35**	3.13 **5.26**	3.10 **5.18**	3.07 **5.11**	3.02 **5.00**	2.98 **4.92**	2.93 **4.80**	2.90 **4.73**	2.86 **4.64**	2.82 **4.56**	2.80 **4.51**	2.77 **4.45**	2.76 **4.41**	2.73 **4.36**	2.72 **4.33**	2.71 **4.31**	9
10	4.96 **10.04**	4.10 **7.56**	3.71 **6.55**	3.48 **5.99**	3.33 **5.64**	3.22 **5.39**	3.14 **5.21**	3.07 **5.06**	3.02 **4.95**	2.97 **4.85**	2.94 **4.78**	2.91 **4.71**	2.86 **4.60**	2.82 **4.52**	2.77 **4.41**	2.74 **4.33**	2.70 **4.25**	2.67 **4.17**	2.64 **4.12**	2.61 **4.05**	2.59 **4.01**	2.56 **3.96**	2.55 **3.93**	2.54 **3.91**	10
11	4.84 **9.65**	3.98 **7.20**	3.59 **6.22**	3.36 **5.67**	3.20 **5.32**	3.09 **5.07**	3.01 **4.88**	2.95 **4.74**	2.90 **4.63**	2.86 **4.54**	2.82 **4.46**	2.79 **4.40**	2.74 **4.29**	2.70 **4.21**	2.65 **4.10**	2.61 **4.02**	2.57 **3.94**	2.53 **3.86**	2.50 **3.80**	2.47 **3.74**	2.45 **3.70**	2.42 **3.66**	2.41 **3.62**	2.40 **3.60**	11
12	4.75 **9.33**	3.88 **6.93**	3.49 **5.95**	3.26 **5.41**	3.11 **5.06**	3.00 **4.82**	2.92 **4.65**	2.85 **4.50**	2.80 **4.39**	2.76 **4.30**	2.72 **4.22**	2.69 **4.16**	2.64 **4.05**	2.60 **3.98**	2.54 **3.86**	2.50 **3.78**	2.46 **3.70**	2.42 **3.61**	2.40 **3.56**	2.36 **3.49**	2.35 **3.46**	2.32 **3.41**	2.31 **3.38**	2.30 **3.36**	12
14	4.60 **8.86**	3.74 **6.51**	3.34 **5.56**	3.11 **5.03**	2.96 **4.69**	2.85 **4.46**	2.77 **4.28**	2.70 **4.14**	2.65 **4.03**	2.60 **3.94**	2.56 **3.86**	2.53 **3.80**	2.48 **3.70**	2.44 **3.62**	2.39 **3.51**	2.35 **3.43**	2.31 **3.34**	2.27 **3.26**	2.24 **3.21**	2.21 **3.14**	2.19 **3.11**	2.16 **3.06**	2.14 **3.02**	2.13 **3.00**	14

(1) Snedecor, George W. (1937). Statistical methods. 1st ed. Iowa: Collegiate Press. In: Senter, R.J. (1969). *Analysis of data: Introductory statistics for the behavioural sciences*. pp.497-498. Atlanta: Scott, Foresman & Co.

Table A: continued.

n_2	n_1 Degrees of Freedom (for Greater Variance)																								n_2
	1	2	3	4	5	6	7	8	9	10	11	12	14	16	20	24	30	40	50	75	100	200	500	∞	
17	4.45 8.40	3.59 6.11	3.20 5.18	2.96 4.67	2.81 4.34	2.70 4.10	2.62 3.93	2.55 3.79	2.50 3.63	2.45 3.59	2.41 3.52	2.38 3.45	2.33 3.35	2.29 3.27	2.23 3.16	2.19 3.08	2.15 3.00	2.11 2.92	2.08 2.86	2.04 2.79	2.02 2.76	1.99 2.70	1.97 2.67	1.96 2.65	17
20	4.35 8.10	3.49 5.85	3.10 4.94	2.87 4.43	2.71 4.10	2.60 3.87	2.52 3.71	2.45 3.56	2.40 3.45	2.35 3.37	2.31 3.30	2.28 3.23	2.23 3.13	2.18 3.05	2.12 2.94	2.08 2.86	2.04 2.77	1.99 2.69	1.96 2.63	1.92 2.56	1.90 2.53	1.87 2.47	1.85 2.44	1.84 2.42	20
24	4.26 7.82	3.40 5.61	3.01 4.72	2.78 4.22	2.62 3.90	2.51 3.67	2.43 3.50	2.36 3.36	2.30 3.25	2.26 3.17	2.22 3.09	2.18 3.03	2.13 2.93	2.09 2.85	2.02 2.74	1.98 2.66	1.94 2.58	1.89 2.49	1.86 2.44	1.82 2.36	1.80 2.33	1.76 2.27	1.74 2.23	1.73 2.21	24
30	4.17 7.56	3.32 5.39	2.92 4.51	2.69 4.02	2.53 3.70	2.42 3.47	2.34 3.30	2.27 3.17	2.21 3.06	2.16 2.98	2.12 2.90	2.09 2.84	2.04 2.74	1.99 2.66	1.93 2.55	1.89 2.47	1.84 2.38	1.79 2.29	1.76 2.24	1.72 2.16	1.69 2.13	1.66 2.07	1.64 2.03	1.62 2.01	30
40	4.08 7.31	3.23 5.18	2.84 4.31	2.61 3.83	2.45 3.51	2.34 3.29	2.25 3.12	2.18 2.99	2.12 2.68	2.07 2.80	2.04 2.73	2.00 2.66	1.95 2.56	1.90 2.49	1.84 2.37	1.79 2.29	1.74 2.20	1.69 2.11	1.66 2.05	1.61 1.97	1.59 1.94	1.55 1.88	1.53 1.84	1.51 1.81	40
50	4.03 7.17	3.18 5.06	2.79 4.20	2.56 3.72	2.40 3.41	2.29 3.18	2.20 3.02	2.11 2.88	2.07 2.78	2.02 2.70	1.98 2.62	1.95 2.56	1.90 2.46	1.85 2.39	1.78 2.26	1.74 2.18	1.69 2.10	1.63 2.00	1.60 1.94	1.55 1.86	1.52 1.82	1.48 1.76	1.46 1.71	1.44 1.68	50
70	3.98 7.01	3.13 4.92	2.74 4.08	2.50 3.60	2.35 3.29	2.23 3.07	2.14 2.91	2.07 2.77	2.01 2.67	1.97 2.59	1.93 2.51	1.89 2.45	1.84 2.35	1.79 2.28	1.72 2.15	1.67 2.07	1.62 1.98	1.56 1.88	1.53 1.82	1.47 1.74	1.45 1.69	1.40 1.62	1.37 1.56	1.35 1.53	70
100	3.94 6.90	3.09 4.82	2.70 3.98	2.46 3.51	2.30 3.20	2.19 2.99	2.10 2.82	2.03 2.69	1.97 2.59	1.92 2.51	1.88 2.43	1.85 2.36	1.79 2.26	1.75 2.19	1.68 2.06	1.63 1.98	1.57 1.89	1.51 1.79	1.48 1.73	1.42 1.64	1.39 1.59	1.34 1.51	1.30 1.46	1.28 1.43	100
150	3.91 6.81	3.06 4.75	2.67 3.91	2.43 3.44	2.27 3.14	2.16 2.92	2.07 2.76	2.00 2.62	1.94 2.53	1.89 2.44	1.85 2.37	1.82 2.30	1.76 2.20	1.71 2.12	1.64 2.00	1.59 1.91	1.54 1.83	1.47 1.72	1.44 1.66	1.37 1.56	1.34 1.51	1.29 1.43	1.25 1.37	1.22 1.33	150
200	3.89 6.76	3.04 4.71	2.65 3.88	2.41 3.41	2.26 3.11	2.14 2.90	2.05 2.73	1.98 2.60	1.92 2.50	1.87 2.41	1.83 2.34	1.80 2.28	1.74 2.17	1.69 2.09	1.62 1.97	1.57 1.88	1.52 1.79	1.45 1.69	1.42 1.62	1.35 1.53	1.32 1.48	1.26 1.39	1.22 1.33	1.19 1.28	200
400	3.86 6.70	3.02 4.66	2.62 3.83	2.39 3.36	2.23 3.06	2.12 2.85	2.03 2.69	1.96 2.55	1.90 2.46	1.85 2.37	1.81 2.29	1.78 2.23	1.72 2.12	1.67 2.04	1.60 1.92	1.54 1.84	1.49 1.74	1.42 1.64	1.38 1.57	1.32 1.47	1.28 1.42	1.22 1.32	1.16 1.24	1.13 1.19	400
1,000	3.85 6.66	3.00 4.62	2.61 3.80	2.38 3.34	2.22 3.04	2.10 2.82	2.02 2.66	1.95 2.53	1.89 2.43	1.84 2.34	1.80 2.26	1.76 2.20	1.70 2.09	1.65 2.01	1.58 1.89	1.53 1.81	1.47 1.71	1.41 1.61	1.36 1.54	1.30 1.44	1.26 1.38	1.19 1.28	1.13 1.19	1.08 1.11	1,000
∞	3.84 6.64	2.99 4.60	2.60 3.78	2.37 3.32	2.21 3.02	2.09 2.80	2.01 2.64	1.94 2.51	1.88 2.41	1.83 2.32	1.79 2.24	1.75 2.18	1.69 2.07	1.64 1.99	1.57 1.87	1.52 1.79	1.46 1.69	1.40 1.59	1.35 1.52	1.28 1.41	1.24 1.36	1.17 1.25	1.11 1.15	1.00 1.00	∞

Chi-square Test

The Chi-square test was used as a test for statistical significance. In this procedure, the objective was to check if the data obtained from discriminant analysis was significantly departed from the shape of normal distribution. The following formula was used for calculation of Chi-square. (4).

$$\chi^2 = \Sigma_i \frac{(f_o^i - f_e^{\prime})^2}{f_e^{\prime}}$$

where χ^2 = Chi-square,

f_o^i = the observed frequency,

$f_e^{\prime}$ = the expected frequency.

The value of Chi-square is increased as the difference between the observed and expected frequencies increase. The significant level of the value obtained from the above formula can be obtained from Table B. In using this table, the degree of freedom depends on the number of rows and columns on the frequency table of the expected and observed values.

Table B: Critical value of χ^2 (1)

df	$\chi^2_{.10}$	$\chi^2_{.05}$	$\chi^2_{.01}$	$\chi^2_{.001}$
1	2.71	3.84	6.64	10.83
2	4.60	5.99	9.21	13.82
3	6.25	7.82	11.34	16.27
4	7.78	9.49	13.28	18.46
5	9.24	11.07	15.09	20.52
6	10.64	12.59	16.81	22.46
7	12.02	14.07	18.48	24.32
8	13.36	15.51	20.09	26.12
9	14.68	16.92	21.67	27.88
10	15.99	18.31	23.21	29.59
11	17.28	19.68	24.72	31.26
12	18.55	21.03	26.22	32.91
13	19.81	22.36	27.69	34.53
14	21.06	23.68	29.14	36.12
15	22.31	25.08	30.58	37.70
16	23.54	26.30	32.00	39.29
17	24.77	27.59	33.41	40.75
18	25.99	28.87	34.80	42.31
19	27.20	30.14	36.19	43.82
20	28.41	31.41	37.57	45.32
21	29.62	32.67	38.93	46.80
22	30.81	33.92	40.29	48.27
23	32.01	35.17	41.64	49.73
24	33.20	36.42	42.98	51.18
25	34.38	37.65	44.31	52.62
26	35.56	38.88	45.64	54.05
27	36.74	40.11	46.96	55.48
28	37.92	41.34	48.28	56.89
29	39.09	42.56	49.59	58.30
30	40.26	43.77	50.89	59.70

(1) Table is abridged from Table IV of Fisher and Yates: Statistical Tables for Biological, Agricultural and Medical Research, Edinburgh: Oliver and Boud. In: Senter, R.J. (1969). *Op. cit.* p.501.

Correlation

See Pearson correlation, point biserial correlation and Reliability.

The Cox-Vargas Difference Indices

Cox and Vargas (5) developed two discrimination indices to compare two methods of item analysis which provided relative evaluative data of items. The first index "Difference Index" was computed by the following equation:

Different Index = P correct high (post-test) - P correct low (post-test)

which was identical to the classical test theory discrimination index. The second index "Pre-test - Post-test Difference Index" was obtained from the following equation:

Pre-test - Post-test Difference Index = P correct pre-test - P correct post-test.

The results obtained by comparing the two indices, showed that the second index was more applicable in situations where variability of the measurement was not the main concern - a condition recommended for constructing a criterion-referenced test. (6).

Difficulty Index or Item Difficulty

Item difficulty was basically defined as the percentage of people who answer an item correctly. In NRT this index was usually defined as the average of the percentage of correct answers in the high and low groups:

$$\text{Item difficulty} = \frac{\text{P correct high} + \text{P correct low}}{2}$$

When this procedure was applied the assumption was made that the middle group respond halfway between the high and low groups. (7).

Criterion-difficulty index = Criterion-difficulty index was defined as the number of people who answer an item incorrectly divided by the number of people who responded to the test item:

$$\text{Criterion-difficulty index} = \frac{\text{P incorrect}}{\text{N}}$$

where N is the number of individuals taking the test item.

In this procedure the item was considered as the criterion. As the criterion-difficulty index approached 1, the majority of individuals were unable to answer the item. As the ratio approached 0, the majority of individuals were able to answer the item correctly. (8).

On the other hand, CRT item facility was defined as the percentage of students who passed the item. (9). This index was used in the present study.

Discriminant Index (CRT)

A good item should normally differentiate between those who know the information being measured and those who do not. In NRM, discriminant index was usually defined as the percentage of students in the high and low groups who answered the item correctly.

Item discrimination = P correct high - P correct low

The most vigorous method of computing discrimination index was the item-test correlation. In this procedure the score on an individual item was correlated with total scores on the test. Point-biserial correlation was the computational method for measuring discrimination index. (10).

In the binomial model, where a score of +1 is given to each person who answered the item correctly and a score of zero to each person who answered the item incorrectly, the item variable is dichotomous. In this situation a product-moment correlation could be computed with Pearson basic formula. The result would be a point-biserial r. Computer programmes for giving Pearson r's from score data automatically yield point-biserial r's between continuous and dichotomous variables. (11).

The discrimination index, computed by any of the above formula, was defined in proportion. It ranges from -1 to +1. A zero value was attributed to a non-discriminating item. Such item was interpreted as either: (a) too easy; (b) too hard; and/or (c) ambiguous.

A positive discriminating index indicated the area of instruction where the programme was not functioning (if the objective of testing was to evaluate the effectiveness of instruction).

A negative discriminating item was usually caused by the following factors:

(a) The item was answered by those students who answered other items incorrectly.

(b) The item was missed by the knowledgeable students who had answered the other items correctly.

(c) The flaws in the item has caused such discrimination.

(d) The instruction was deficient.

In most cases the reason for a negative discrimination was due to the item difficulty rather than as the last category indicates. (12).

In NRT, discrimination index was used for item analysis, that is to say, to generate items that could differentiate between individuals. Therefore, the ideal discrimination index had a value of .20 or more. This index was used in relation to item difficulty (Table C).

In CRT, variability amongst individuals was not desirable. Use of NRT discriminating index indicated that positively and negatively discriminant items were the result of the deficiency of the instruction which might require revision. A non-discriminating item was interpreted as an ideal situation in which all students got an item correct. This was verified by validity of the test item. (13).

Since the CRT items were not expected to differentiate amongst individuals but aid in making decisions on their fail or pass of the item, different discrimination index was required. The formula for this discrimination index was as follows (14):

$$\text{Index of discrimination} = \frac{R_P}{n_P} - \frac{R_F}{n_F}$$

where:

R_p = number of students who passed the total test, and answered the item correctly,

R_F = number of students who failed the total test, and answered the item correctly,

n_p = number of students who passed the total test,

n_F = number of students who failed the total test,

which was similar to Brennan's validity index (13) for CRT and had been used for the latter cases throughout this thesis.

Table C: Maximum and minimum possible indeces of discrimination for selected difficulty indeces (1).

Item difficulty index	Maximum possible discrimination	Minimum possible discrimination
.00	.00	.00
.10	.20	-.20
.20	.40	-.40
.30	.60	-.60
.40	.80	-.80
.50	1.00	-1.00
.60	.80	-.80
.70	.60	-.60
.80	.40	-.40
.90	.20	.20
1.00	.00	.00

(1) Scannell, Dale. P. and Tracy, D.B. (1975). *Testing and measurement in the classroom*. p.226. Boston: Houghton Mifflin Co.

Discriminant Analysis

Discriminant analysis was a technique which was used to identify the basic ways in which control and experimental groups differed. (14). In this procedure, the groups were classified as a set of independent variables.

In the case of the ecology test, the objective of Discriminant analysis was to discriminate between experimental and control groups. Since each group had tried 42 test items, discriminant analysis was used to identify the difference between the achievement of each item amongst the two groups.

In discriminant analysis, a linear combination of the discriminant variables is worked out (6.435). (15).

$$D_i = d_{i1}Z_1 + d_{i2}\ Z_2 + \ldots + d_{ip}\ Z_p$$

where D_i = is the score on discriminant function i.

d_s' = the weighting coefficient.

Z_s' = the standardized value of the p discriminating variables used in the analysis.

Ideally, the discriminant scores (D_s'), for the cases within the two above groups, was considered to be similar. In the process of computation, functions were formed to maximize the separation of the two groups. This was preformed by the computation of "F" value.

Following the F value computation for the score, the variables were examined in two stages of the computation. In the first stage the variables were analysed by appropriate statistical procedures. Then in the second stage they were classified by their discrimination functions. (16)(17).

There were several statistical methods that one can choose for this special case. In the Discriminant analysis of the above case, Method + Direct was used since the intermediate results were not of any interest. The F value obtained (Table A) as the result of statistics 6; univariate F ratio, was the one-way analysis of variance test for equality of group means on a single discriminating variable. Table of F ratio showed that for 926 cases involved, the F value should be above 1.08 to be significant.

The overall discriminant analysis of the experimental and control groups was decided by Chi-square between the two independent variables. This result was the end product of the analysis and classification functions, mentioned above.

Frequency Distribution

Frequency distribution was the result of sub programme frequencies in the SPSS. The results of these frequencies and others were graphically shown in the following ways. (18).

(a) Frequency polygon: this was obtained by connecting the mid points of the highest point in each bar of the histogram.

(b) Histogram of frequency bargraph.

Index of Item-Objective Congruence

To evaluate item-objective congruence of the biology test items, Rovinelli and Hambleton (19) Index of Item-Objective Congruence was used. This index was a revised version of the Hemphill-Westie (20) index of item homogeneity, with the following improvements:

(a) The index minimum and maximum was -1 to +1 in contrast to -0.40 to +0.67 of the Hemphill-Westie index.

(b) The value of +1 was used when there was a definite agreement that an item was a measure of an objective, -1 for the definite disagreement that a test was a measure of an objective and a value of 0 was used when subject specialist could not decide whether an item had been a measure of an appropriate objective.

(c) The index was improved in such a way that was not affected either by the number of objectives involved nor by the number of content specialists who rate items against objectives.

The following is the computational formula of the above index:

$$I_{io} = \frac{(M-1)\ S_o - S_o'}{2N(M-1)}$$

where I_{io} = the index of congruence for item i and objective o.

M = the number of objectives.

N = the number of content specialists.

S_o = the sum of the rating assigned to objective o.

S_o' = the sum of the rating assigned to all objectives except objective o.

Method of collecting data and computation - Once a content specialist rated an item against objectives, there would be three possible values assigned to an item for its objective congruence. A value of +1 meant the content specialist definitely agreed that the item measure the appropriate objective. A value of -1 meant the content specialist definitely disagreed that the item could have been a measure of any of the objectives, and a value of 0 indicated that the content specialist could not decide whether the test was a measure of any of the objectives.

In the case of the biology test 45 test items were rated by 12 content specialists (subject teachers) against three objectives: (1) knowledge; (2) comprehension; and (3) application. The following table represents data being collected for the item one of the biology test:

Judges	Objectives			
	1. Knowledge	2. Comprehension	3. Application	
1	+1	-1	-1	
2	+1	-1	-1	
3	-1	+1	-1	
4	+1	-1	-1	
5	+1	-1	-1	
6	+1	-1	-1	
7	-1	+1	-1	
8	+1	-1	-1	
9	+1	-1	-1	
10	+1	-1	-1	
11	+1	-1	-1	
12	+1	-1	-1	
S_o	+8	-8	-12	$S_o = +8$ $S'_o = -20$

By applying the notations of the above formula we have $I_{io} = I_{1j}$, $M = 3$, $N = 12$, $S_o = +8$ and $S_o' = -20$.
Therefore

$$I_{11} = \frac{(3-1)(+8)-(-20)}{2(12)(2-1)} = \frac{16 + 20}{48} = 0.75$$

Seventy-five percent of the content specialists agreed that item 1 was a measure of objective one (Knowledge). Since this objective was congruence to the area in the content from which the test was generated, then the test is measuring what it was planned to measure, and it is valid.

In the case of the data obtained from the biology teachers, the right answer to each test was not provided. A close inspection of the data showed some teachers had given wrong answers to the test items and rated them against the objectives. This data could not be used for the above validation procedure and was omitted.

Omitting the above mentioned data simplified the computing procedure further.

Item Facility

See Difficulty Index.

Item Validity

Brennan (21) described an index for measuring the validity of the criterion-referenced test items which is based on the concept of discriminant index. (See CRT discriminant index):

$$VS = (C_u/n_u) - (C_1/n_1)$$

where:

VS = validity for measure of state,

C_u = the number of students in the master group who got the item correct,

n_u = the number of students in the master group who got the item correct,

C_1 = the number of students in the non-master group,

and

n_{u^2} = the total number of students in the non-master group.

This value of index varies between -1 and +1.

Example: the following values were obtained from question one of the Form A.

$C_u = 130$, $n_u = 288$, $C_1 = 130$, $n_1 = 638$

from the above formula we have:

$$VS = (130/288) - (130/638) = .45-20 = .25$$

The validity of the test was computed as .25. The test is discriminating between master and non-masters over the whole population of the students.

Kolmogrov-Smironov (K-S) One Sample Test

K-S test was used for ordinal scale data. It measured the goodness of fit between a specified theoretical distribution of scores and an observed one. The result was measured in terms of maximum deviation (or D) between the two. (22)(23).

D = maximum 1 $F_o(X)$ - $S_N(X)$ 1

where

D = maximum deviation between specific theoretical distribution and the observed data,

$F_o(X)$ = a theoretical cumulative frequency distribution under 110,

$S_N(X)$ = the observed cumulative frequency distribution.

The underlying assumption, in this test, was that the population under study had been obtained by random sampling procedure from the whole population.

When the cumulative distribution functions for the observed and the theoretical distribution were computed, the difference was interpreted in terms of the Null Hypothesis by the use of the Table C. If the value of D maximum was not significant, there was no difference between the observed and theoretical distribution. A positive or negative value of D indicated that the data and theoretical distribution differed.

Table C: Table of critical values of D in the Kolmogrov-Smironov one sample test(1)

Sample size (N)	Level of significance for D = maximum $\lvert F_0(X) - S_N(X)\rvert$				
	.20	.15	.10	.05	.01
1	.900	.925	.950	.975	.995
2	.684	.726	.776	.842	.929
3	.565	.597	.642	.708	.828
4	.494	.525	.564	.624	.733
5	.446	.474	.510	.565	.669
6	.410	.436	.470	.521	.618
7	.381	.405	.438	.486	.577
8	.358	.381	.411	.457	.543
9	.339	.360	.388	.432	.514
10	.322	.342	.368	.410	.490
11	.307	.326	.352	.391	.468
12	.295	.313	.338	.375	.450
13	.284	.302	.325	.361	.433
14	.274	.292	.314	.349	.418
15	.266	.283	.304	.338	.404
16	.258	.274	.295	.328	.392
17	.250	.266	.286	.318	.381
18	.244	.259	.278	.309	.371
19	.237	.252	.272	.301	.363
20	.231	.246	.264	.294	.356
25	.21	.22	.24	.27	.32
30	.19	.20	.22	.24	.29
35	.18	.19	.21	.23	.27
Over 35	$\frac{1.07}{\sqrt{N}}$	$\frac{1.14}{\sqrt{N}}$	$\frac{1.22}{\sqrt{N}}$	$\frac{1.36}{\sqrt{N}}$	$\frac{1.63}{\sqrt{N}}$

* Adapted from Massey, F. J., Jr. 1951. The Kolmogorov-Smirnov test for goodness of fit. *J. Amer. Statist. Ass.*, 46, 70, with the kind permission of the author and publisher.

Mean (M)

Mean is the measure of central tendency for variables measured at the interval level. Mean is calculated by the following formula. (24).

$$\overline{X} = \frac{\Sigma_{i=1}^{N} X_i}{N}$$

where

$\overline{X}$ = mean,

X_i = score obtained from each case,

N = number of cases.

In some statistical textbooks $\overline{X}$ is represented by μ.

Pearson Correlation

The Pearson correlation is used to measure the degree of relationship between two interval-level variables. This value is calculated by the following formula. (27).

$$r = \frac{\Sigma_{i=1}^{N}(X_i-\overline{X})(Y_i-\overline{Y})}{\left\{\left[\Sigma_{i=1}^{N}(X_i-\overline{X})^2\right]\left[\Sigma_{i=1}^{N}(Y_i-\overline{Y})^2\right]\right\}^{\frac{1}{2}}}$$

where X_i = ith observation of variable X,

Y_i = ith observation of variable Y,

N = number of observations,

$\overline{X}$ = mean of variable X,

$\overline{Y}$ = mean of variable Y.

A two tailed test of statistical significance was calculated for each correlation coefficient, since the positive or negative correlation between the test items were not explicitly known. (28).

Point Biserial Correlation

Point biserial correlation coefficient is preferred to biserial correlation coefficient for calculating discriminant index of the test items (29). Where, as in the case of the ecology test, the data is interval and dichotomized into 1 and zero, the computer programme for Pearson correlation automatically yielded point biserial correlation coefficient for the test items (-1). (30).

In the course of computing reliability of the test, the discriminant index of the test is calculated and specified under item total correlation.

Discriminant Index (NRT)

See point biserial correlation and CRT discriminant index for the discussion of its various values.

Median

Median is an index of central tendency. It is the mid point in a set of ranked scores that divide a distribution into two equal halves (7). (20).

<u>Mode</u>

Mode is an index of central tendency. It is the most frequently occurring score in a distribution. In some distribution there might be more than one mode which are named as bimodal, trimodal etc. (21).

Reliability

Reliability is a measure of consistency of the test scores. It can be defined either as the (a) squared correlation between the true and observed scores, or (b) ratio of the variance of true score to the variance of the observed scores.

There are three common methods for obtaining reliability coefficient:

1. Reliability as a measure of equivalence

   If parallel test items are tried by the same individuals, the scores may have equal means, variance and intercorrelations. The correlation coefficient is an estimate of reliability of the parallel test items.

2. Reliability as a measure of stability

   An item is considered to be a good item if the score obtained from its two administrations of the item by the same individual is consistent. Correlation coefficient, e.g. phi coefficient, provides an estimate of this type of reliability.

3. Reliability as a measure of internal consistency

   A good test item usually behaves similarly to the other items which measure the same objectives. Internal consistency may be computed by biserial-correlation between the score of an item and the total score on all items measuring that objective. Where scores are dichotomized into 1 and zero Kuder-Richardson's formula 20, Cronbach's Coefficient Alpha and Hoyt's reliability coefficient provide identical results. (31).

A criterion-referenced test item should be internally consistent. (32)(33).

The fact that CRT items should have no variabilities suggests that classical test theory concept of reliability is not applicable for estimating reliability of the test. However, this concept has been defined for a situation that several items were used to measure one single objective over a group of individuals who had the same instruction. (34). Where several groups of students with different instructions are used the variability is inevitable. (35). Therefore, the classical test theory concept of reliability is fully applicable. However the low variability of the CRT items lead to a low value of reliability coefficient.

The existing formulae for computing CRT reliability were all based on the first assumption discussed above. Some of these indeces were for pre- and post-test situations. The others were for single test administration conditions but had no general application in criterion-referenced measurement since. They have been used in specific situations to provide specific answers for specific problems. (49)(50)(51)(52).

Skewness

Skewness was a measure of deviation from normal distribution of the scores, a measure of symmetry. It was calculated by the following formula:

$$\text{Skewness} = \frac{\Sigma_{i=1}^{N} \left[(X_i - \bar{X})/S \right]^3}{N}$$

where all the symbols were identical to those described for the mean and S.D. In the SPSS, a more elaborated formula was used.

When the distribution was a completely bell-shaped curve, the value of Skewness was zero. A positive value indicated that the scores were clustered more to the left of the mean and the negative value indicated clustering to the right. (36).

Kurtosis

Kurtosis was a measure of relative peaking or levelling of the curve defined by the distribution of scores. The Kurtosis of a normally distributed score was zero. A positive Kurtosis indicated a more peaked and a negative Kurtosis a more level distribution than a normal distribution curve. Kurtosis was computed by the following formula:

$$\text{Kurtosis} = \frac{\Sigma_{i=1}^{N}\left[(X_i-\overline{X})/S\right]^4}{N} - 3$$

where all the symbols were identical to those of the mean and S.D. formula.

The term of platykurtic distribution and Leptokurtic distribution were used for positive and negative Kurtosis values. The normal distribution was mesokurtic. (37).

Spearman and/or Kendall Rank-Order Correlation

Both of these correlation coefficients were used to measure the degree of association that exists between two ordinal scales of ranked data. Spearman rank correlation coefficient or rho (alternatively r_s) was used for small numbers of cases where a few number of ties exist at each rank. In this case the data was treated to be more or less continuous. Spearman's r_s can be formally defined as (38):

$$r_s = 1 - \frac{6\Sigma_{i=1}^{N} d_i^2}{N^3 - N}$$

where

r_s = Spearman rank-order correlation coefficient,

d = difference between the ranks of the two variables for case i, and,

N = number of cases.

In computation procedure it was necessary to correct the above formula for the occurrence of tied ranks. Therefore Spearman's r_s can be redefined as (39):

$$r_s = \frac{T_x + T_y - \Sigma_{i=1}^{N} d_i^2}{2(T_x\ T_y)^{\frac{1}{2}}}$$

where all the symbols were exactly the same as the above formula.

The significance of r_s is determined by comparing the quantity of:

$$r_s\left(\frac{N - 2}{1 - r_s^2}\right)^{\frac{1}{2}}$$

with the student's t distribution with N - 2 degrees of freedom.

Kendall rank correlation coefficient or τ (tau) is more applicable for a large number of cases where there exists a large number of tied ranks in the data. Kendall's tau can be defined as (40):

$$\tau = \frac{S}{\frac{1}{2}N\ (N-1)}$$

where:

τ = Kendall rank correlation coefficient,

S = statistic S,

N = number of cases.

When the correction for tied rank is applied, the formula is redefined as (41):

$$\tau = \frac{S}{\sqrt{\frac{1}{2}N\ (N-1) - T_x}\ \sqrt{\frac{1}{2}N\ (N-1) - T_y}}$$

where:

T_x = $\frac{1}{2}\ \Sigma t\ (t-1)$ and,

t = the number of tied observations in each group of ties on the S variable,

T_y = is the same as y variable.

The significance of tau is determined by comparing tau to a normal distribution with a standard deviation equal to:

$$\left(\frac{4N + 10}{9N\ (N-1)}\right)^{\frac{1}{2}}$$

Standard Deviation (SD)

Standard deviation is the square root of the arithmetic mean of the squared deviation from the mean. S.D. is a measure of dispersion about the mean of an interval-level variable. It is calculated by the following formula:

$$\sigma = \text{S.D.} = \left[\frac{\Sigma_{i=1}^{N} (X_i - \overline{X})^2}{N} \right]^{\frac{1}{2}}$$

where the symbols are exactly the same as the ones mentioned for the formula of the mean above. The square of the S.D. is called variance and is shown by S^2 or σ^2. (48).

Variance

Variance is the square value of the S.D. and is calculated by the following formula:

$$\sigma^2 = \frac{\Sigma_{i=1}^{N} (X_i - \overline{X})^2}{N-1}$$

Variance is a measure of variability. The smaller the variance the smaller the distance of scores from the mean. The values of variance is much larger than S.D. unless the values of the latter is less than one. (42).

Standard Error (S.E.)

Standard error is an estimate of the potential degree of discrepancy between the sample mean and the unknown population mean. In this procedure, we consider that there is an indefinite number of samples from the population. The mean of these samples is the true population mean which is the average of all different means in the samples. Since the distribution of these means would constitute a normal distribution, it has a standard deviation. The standard deviation of this distribution is called standard error. S.E. can be estimated by dividing the S.D. by the square root of the number of cases.

$$\text{S.E.} = \frac{\text{S.D.}}{\sqrt{N}}$$

This value is a good estimation of the significant level of the relation between two interval-level distributions. In correlational statistics it is used for calculating the significance level. The computation formula is as the following:

$$S_{y.x} = S_y \sqrt{1 - r^2}$$

where r is the correlation coefficient. (43).

T-Test

T-Test in SPSS is based on the computation of student's t statistics. (44). T-test is used to determine whether or not the difference between two sample means is big enough to be judged as the result of the true difference between the populations. In this process a significant level is chosen to avoid the acceptance of differences resulting from chance or sample variability.

A general formula of t may be presented as follows:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

where

t = the value of t by which the statistical significance of the mean difference will be judged.

$\overline{X}_1$ = the mean of sample 1.

$\overline{X}_2$ = the mean of sample 2.

S_1^2 = the variance of sample 1.

S_2^2 = the variance of sample 2.

n_1 = the number of subjects in sample 1.

n_2 = the number of subjects in sample 2.

Once the value of t was computed (negative or positive), its degree of freedom is decided, and by the use of the t-table; the null hypothesis is accepted or is rejected.

In the computation of the t statistics population variability and sample size affect the results. Where there are populations with unequal variance, computation of student's t cannot be computed. Instead, an approximation to t may be computed and the degrees of freedom also follows a different computation procedure. (45).

In the above case and when the population variance is not known the computation of an F value will be helpful to interpret the t value (46):

$$F = \frac{\text{larger } S^2}{\text{smaller } S_2}$$

In this formula a null hypothesis of Ho : $\sigma_1^2 = \sigma_2^2$ with alternative Ho : $\sigma_1^2 \neq \sigma_2^2$ is formulated. The significance level α' is indicated beforehand to decide the value of F in the F table (Table A) for its corresponding degrees of freedom. (47).

Validity

See Item Validity.

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